The Welding Engineer

Reg. U. S. Pat. Office

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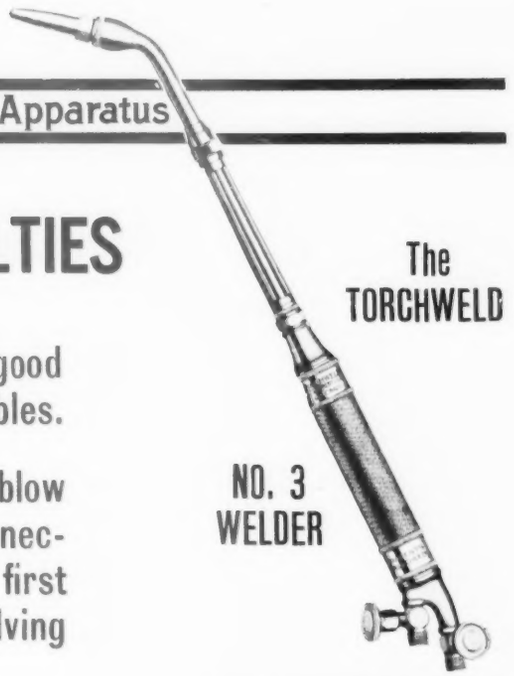
"TORCHWELD"

The Standard of Efficiency in Welding & Cutting Apparatus



OVERCOME YOUR DIFFICULTIES

You'll have to admit it sounds mighty good to hear of a way to overcome your troubles.

You don't have to accept hard spots, blow holes, oxidized welds and flashbacks as necessary evils, but efficient apparatus is the first condition you'll have to consider in solving the problems.

The TORCHWELD system of mixing gases insures perfect gas mixtures. That the system is right has been proven beyond doubt.

Send for booklet explaining how the other fellow overcame his troubles. It will tell you how to overcome yours.

TORCHWELD PRODUCTS

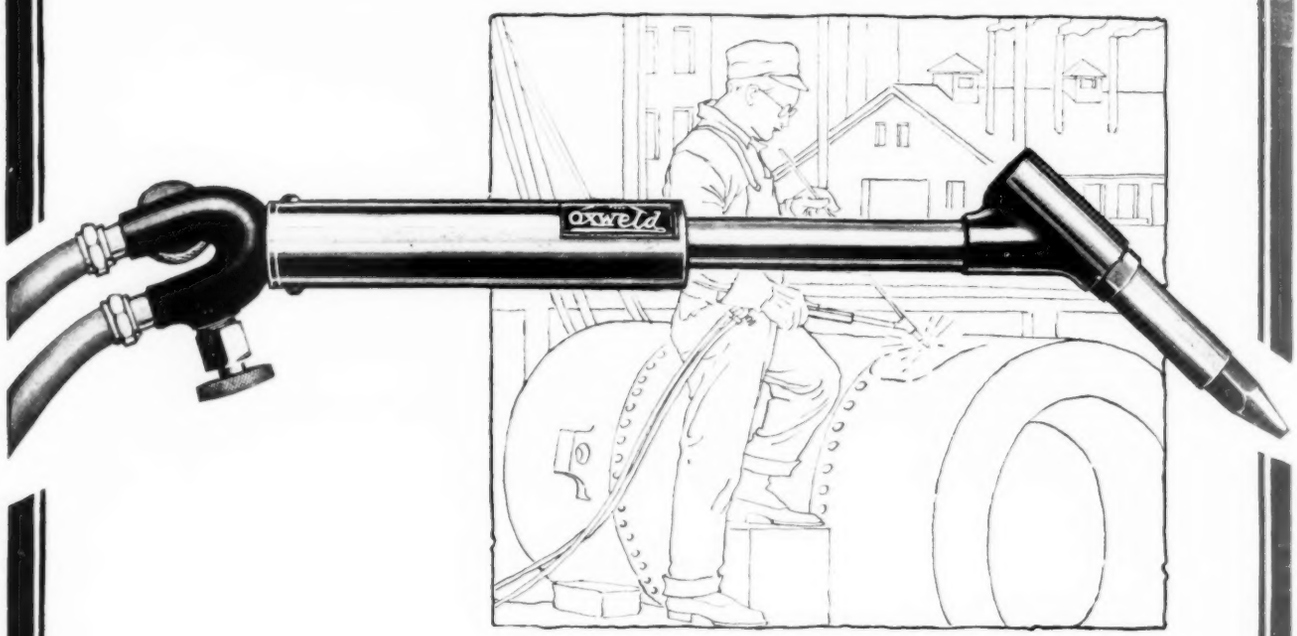
Welding Apparatus
Cutting Apparatus
Lead Burning Apparatus
Decarbonizing Apparatus
Welding Materials
Brazing Materials
Accessories

TORCHWELD EQUIPMENT COMPANY
FULTON AND CARPENTER STREETS CHICAGO

Cleveland Pittsburgh | New York Detroit | Minneapolis Memphis

WELDING TORCHWELD CUTTING

Oxweld



WELDERS use Oxweld Apparatus to make sure of satisfactory results. . . . They know that Oxweld Apparatus represents—

Tested Materials
Careful Workmanship
Painstaking Inspection
Scientific Control in Manufacture

—all of which means that the full measure of the operator's skill becomes effective.

OXWELD ACETYLENE COMPANY
NEWARK, N. J. CHICAGO LOS ANGELES
World's Largest Maker of Equipment for Welding and Cutting Metals

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We Want Several

Active Sales Agents

For Our

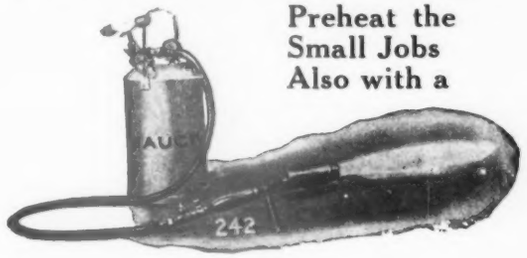
HYDREX FLOW INDICATOR

Our instruments are used in numerous first-class welding and cutting shops with most gratifying results.

HYDREX ENGINEERING CORPORATION

Hutchinson Bldg. Buffalo, N. Y.

Preheat the Small Jobs Also with a



Hauck Kerosene Burner

before applying the welding torch

Angle iron 1"x⅛" when preheated by a cheaper fuel shows a saving of 75% in welding time besides insuring a perfect weld.

Hauck Preheaters use kerosene oil as fuel which at 16 cents a gallon produces more heat in half the time than charcoal at 60 cents a bushel. Furthermore, Hauck Preheaters eliminate ashes, smoke and obnoxious gases experienced through the use of charcoal.

Write for our free booklet on preheating; it will interest you.

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Prices—Right
Delivery—From Stock

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have been developed with the growth of the Welding Process, having been on the market since welding was in its infancy, and the constantly increasing demand for these supplies is the best testimonial that can be offered.

PRICES CHEERFULLY QUOTED

Rods Wires Fluxes

BIERMAN-EVERETT FOUNDRY CO.

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1 Apparatus substantially built of the best materials made. Gas and oxygen mixing and consumption guaranteed to be in correct proportions to produce the correct flame and economy.

2 All accessories and supplies of the best quality.

3 The most completely equipped welding shop in New York City and capable of handling the largest castings or any quantity of manufacturers work—men and apparatus supplied for outside work.

4 A large stock of acetylene and Oxygen always on hand to supply our trade at the lowest market prices.

5 Everything needed for oxy-acetylene work we supply.

K-G Welding & Cutting Co.

Incorporated

556 West 34th St., New York City

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Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

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Commercial Acetylene Welding Co.
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The Welding Engineer
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United States Welding Co.
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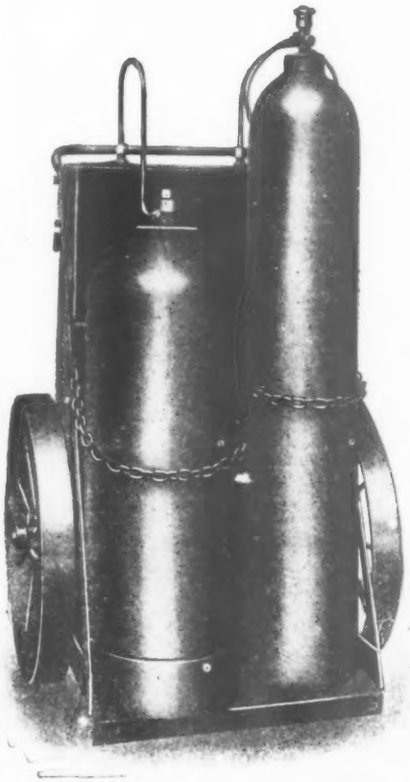
International Oxygen Co.
Universal Oxygen Co.

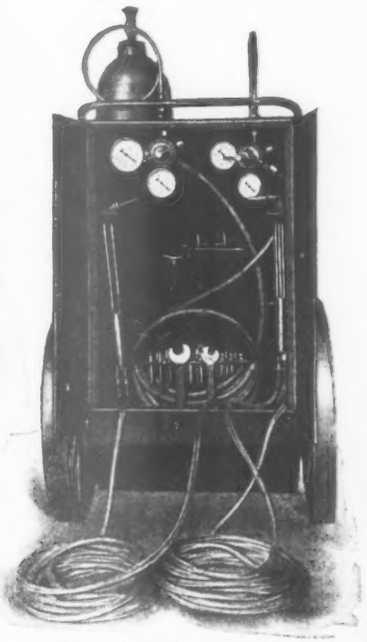
DAVIS-BOURNONVILLE
Portable Welding and Cutting Outfit



Front of D-B Cabinet Truck.

An all-steel two-wheel cabinet truck for transporting oxy-acetylene and oxy-hydrogen welding and cutting equipment is offered as a complete portable unit permitting operation direct from the truck and affording the maximum safety and convenience in transportation and use.

An upright steel cabinet forms the body of the truck, the forward base of which projects as a platform to support an oxygen cylinder and an acetylene or hydrogen cylinder. The cabinet and all connections are so designed that when fully equipped, the operator has only to open the doors, take down the torch and turn on the gases to be ready for work. When the work is completed the torch and hose are assembled in the cabinet, the doors locked and the outfit ready to move. Cylinders are changed without disturbing the regulators.



Cabinet Open for Use.

Send for descriptive bulletin Form 507.

Rear of Truck, Cabinet Closed.

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General Offices, Jersey City, N. J.

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The Imperial Brass Mfg. Co.
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Burdett Oxygen Co.
The Imperial Brass Mfg. Co.
Chicago Eye Shield Co.
International Oxygen Co.
Torchweld Equipment Co.
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Wilson Welder & Metals Co.
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Air Reduction Sales Co.
Burdett Oxygen Co.
International Oxygen Co.
Universal Oxygen Co.
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Air Reduction Sales Co.
Bierman-Everett Fdy. Co.
Burdett Oxygen Co.
Kentucky Oxygen-Hydrogen Co.
The Imperial Brass Mfg. Co.
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International Oxygen Co.
Oxweld Acetylene Co.
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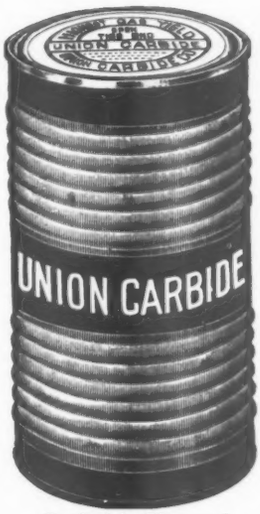

Packed in Blue and Gray Drums

Union Carbide Sales Company

New York City, 42nd St. Building — **Chicago, Ill., Peoples Gas Building** — **San Francisco, Cal., Kohl Building**

SOLE DISTRIBUTORS OF

UNION CARBIDE

"World's Best Quality—Highest Gas Yield"

For Oxy-Acetylene Welding Plants

Contractors' Flare Lights, Torches and Private and Municipal Lighting Plants

"Union Carbide" is packed in 100-lb. blue and gray drums marked conspicuously, "UNION CARBIDE."

The following sizes are carried in stock in 100-lb. drums:

$3\frac{1}{2}$ x 2 in. —a large size.

$1\frac{1}{4}$ x $\frac{3}{8}$ in. —an intermediate size.

2 x $\frac{1}{2}$ in. —a medium size.

$\frac{1}{4}$ x 1/12 in. —finely crushed size.

Union Carbide in the Generator sizes above listed will be shipped direct to consumers from a **Union Carbide Sales Co.** warehouse at any one of the following points where large stocks are kept on hand:

ALABAMA
Birmingham—1916 Morris Ave.
Mobile—16 S. Commerce St.
Montgomery—114 N. Perry St.
ARIZONA
Phoenix—42 S. Central Ave.
ARKANSAS
Fort Smith—109-123 So. Ninth St.
CALIFORNIA
Fresno—932 H St.
Los Angeles—639 Gibbon St.
Sacramento—1523-31 Front St.
San Diego—326-336 Fifth St.
San Francisco—Kohl Building.
COLORADO
Denver—Nineteenth and Wazee Sts.
CONNECTICUT
Hartford—412 Trumbull St.
DISTRICT OF COLUMBIA
Washington—Maryland Ave. and 9th St., S. W.
FLORIDA
Jacksonville—515 W. Bay St.
Tampa—107 Madison St.
GEORGIA
Atlanta—Cor. Haynes and Rhodes Sts., P. O. Box 1594.
Savannah—Ogeechee Canal, South of Bay St., P. O. Box 78.
ILLINOIS
Chicago—Peoples Gas Bldg., Michigan Blvd.
Decatur—133-147 W. Williams St.
East St. Louis—600 Walnut Ave.
Peoria—100-110 Edmund St.
Monmouth—124 E. Archer Ave.
Marion—315 S. Granite St., Box 747.
Quincy—222 S. Eighth St.
Streator—702 East Elm St.
INDIANA
Evansville—1601 Illinois St.
Fort Wayne—2216 Broadway.
Indianapolis—110-112 S. Alabama St.
Terre Haute—921 Wabash Ave.
IOWA
Davenport—118 Harrison St.
Des Moines—3rd and Elm Sts.
Dubuque—8th and Washington Sts.
Fort Dodge—10 S. 8th St.
Ottumwa—207-9-11 S. Washington St.
Sioux City—925 Fourth St., P. O. Box 398.
Waterloo—1209 E. 4th St.
KANSAS
Pittsburg—109 W. Third St.
Salina—154 So. 5th St.
Wichita—535-543 West Douglas Ave.
KENTUCKY
Louisville—126 E. Main St.
Middlesboro—1701 Cumberland Ave.
LOUISIANA
New Orleans—819-21 Julia St.

MAINE
Portland—11 Exchange St.
MARYLAND
Baltimore—19 E. Lombard St.
Cumberland—1 N. Liberty St.
Salisbury—Opp. Fulton Station.
MASSACHUSETTS
Boston—(See Cambridge "A.")
Cambridge—241 Albany St.
Springfield—Napier St.
MICHIGAN
Detroit—Grand River and Lorain Ave.
Grand Rapids—500 Shawmut Ave., N. W.
Hancock—First National Bank Bldg.
Iron Mountain—215 E. A St.
Jackson—172 South Water St.
Muskegon—43 No. Terrace St.
Saginaw—1830 No. Michigan Ave.
Sault Ste. Marie.
MINNESOTA
Minneapolis—334 N. First St.
Virginia—413 Chestnut St.
MISSISSIPPI
Vicksburg—1312 Washington St.
MISSOURI
Kansas City—1316-1318 W. Eighth St.
St. Joseph—920 S. Sixth St., Sta. "A."
St. Louis—(See East St. Louis, Ill.)
NEBRASKA
Omaha—1007-9-11 Jones St., Union Sta. P. O.
NEW JERSEY
Camden—West and Clinton Sts.
Jersey City—554-56 Henderson St.
NEW YORK
Albany—Montgomery and Colonie Sts.
Binghamton—21 Jarvis St.
Buffalo—1336 Genesee St.
Geneva—Exchange St. and Railroad Pl.
Hurleyville.
Jamaica—11 New York Ave.
Kingston—O'Neil St., near Broadway.
New York.
Niagara Falls.
Poughkeepsie—Smith St. and N. Y., N. H. & H. R. R. Tracks.
Utica—135 Hotel St.
Watertown—438 Court St.
Whitehall—22 Main St.
NORTH CAROLINA
Charlotte—Post Office Box 777.
Raleigh—107 Fayetteville St.
Wilmington—Room 16 Masonic Temple, 12 N. Front St.
NORTH DAKOTA
Fargo—17 Broadway.
OHIO
Canton—400 Walnut Ave. S. E.
Cincinnati—67 Plum St.
Cleveland—601 The Citizens' Building.
Columbus—330 Dublin Ave.
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Lima—338 East High St.
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Oklahoma City—27-29 E. Grand Ave.
Tulsa—1—11 No. Boulder St.
OREGON
Portland—Fifteenth and Hoyt Sts.
PENNSYLVANIA
Beaver—359 Beaver St.
Du Bois—Webber Ave. and Franklin St.
Erie—1426 Chestnut St.
E. Greensburg—Clark and George St.
Harrisburg—627 Walnut St.
Johnstown—Messenger St. & B. & O. R. R.
Pittsburgh—1202 Chamber of Commerce Building.
Pottsville—Railroad and Sanderson Sts.
Scranton—Penn Ave. and Vine St.
Shamokin—5th and Walnut Sts.
Williamsport—Canal and Court Sts.
SOUTH CAROLINA
Charleston—No. 6 Liberty St.
TENNESSEE
Chattanooga—627 Volunteer State Ins. Bldg.
Knoxville—426 West Depot Ave.
Memphis—671 South Main St.
Nashville—105-107-109 Broadway.
TEXAS
Dallas—802-810 Cadiz St.
El Paso—900 E. Overland St.
Houston—Baker and Cedar Sts., Box 745.
San Antonio—Cor. Leal and N. Salado Sts.
Waco—13th and Mary Sts.
UTAH
Salt Lake City—118 W. Second South St.
VIRGINIA
Lynchburg—1324 Commerce St.
Norfolk—513 Front St.
Richmond—18th and Cary Sts.
WEST VIRGINIA
Bluefield—195 Roanoke St.
Charleston—Broad St. and K. & M. R. R.
Fairmont—"A" Street.
Huntington—820 3rd Avenue.
WASHINGTON
Seattle—1103 First Ave.
Spokane—711 Railroad Avenue.
WISCONSIN
La Crosse—Front and King Streets.
Madison—513-19 Williamson Street.
Milwaukee—120-124 Jefferson St.

We recommend our customers to **select** from the list, the **city** from which the quickest delivery and lowest freight rate can be obtained, **and address their orders to "Union Carbide Sales Company"** at the distributing point selected **accompanied by remittance.**

Please address request for information or special correspondence to either the New York or Chicago office.

Patented

Each Year

finds a greater number of manufacturers specifying U. S. gauges—in every line.

The reason is unequaled quality and durability—due to springs being tempered by special U. S. processes and other patented features.

Special attention is called to the solid metal wall between the internal mechanism and the recording dial. This patented device saves the glass front from being broken in the event of an explosion and prevents injury from flying glass.

Ask for Catalogue 72.

U.S. GAUGE CO. N.Y.

United States Gauge Co.

67 Wall Street, New York

Chicago Boston Detroit Philadelphia New Orleans San Francisco Montreal

U.S. GAUGE CO. N.Y.

Special Offer in Welding Rods

During the month of November we will accept and make immediate shipment of orders of 100 lbs. and over of any specified thickness as listed below or an assortment of not less than 100 lbs. of various kinds at the following ton-lot prices:

K-O CAST IRON RODS, 24 inches long, 3/16" diam.	$0.11½ p. lb.
K-O CAST IRON RODS, 24 inches long, 1/4" diam.	.10 p. lb.
K-O CAST IRON RODS, 24 inches long, 5/16", 3/8", 1/2"	.09 p. lb.
ARMCO IRON RODS, 99.84% pure, 36" long, 1/8" diam.	.12¾ p. lb.
ARMCO IRON RODS, 99.84% pure, 36" long, 3/16", 1/4", 5/16"	.12½ p. lb.
Tobin BRONZE, drawn, 36" long, 1/8" and 3/16"	.60 p. lb.
Tobin BRONZE, drawn, 36" long, 1/4"	.50 p. lb.
K-O CAST ALUMINUM RODS, 1/4" and 5/16"	.80 p. lb.

F. O. B. Louisville, Ky.

We guarantee these welding rods to be of the highest quality or you have the privilege to return same to us and money will be refunded.

We carry the largest stock of welding supplies and accessories, such as welding rods, fluxes, goggles, Asbestos wearing apparel, preheating torches of all descriptions, Acetylene generators, Oxygen manifolds, Welding tables, etc., at lowest prices.

Write to our Supply Department for complete price list.

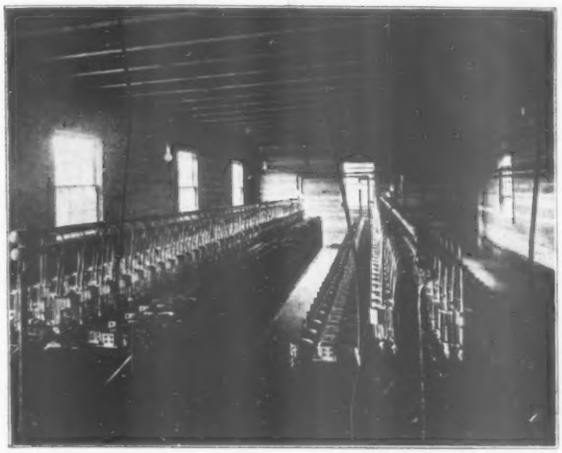
KENTUCKY OXYGEN-HYDROGEN COMPANY

INCORPORATED

MANUFACTURERS · OXYGEN AND HYDROGEN

CUTTING and WELDING APPARATUS and SUPPLIES

LOUISVILLE, KY.



Control Your Supply of Oxygen and Hydrogen

The efficiency of your welding plant is always dependent upon a constant and sure supply of Oxygen. You can not afford to hold up important work because of a shortage of gas.

Electrolabs apparatus assures a **constant** and **sure** supply of **pure** Oxygen and Hydrogen for cutting and welding. Both gases cost less than half the cost of Oxygen in Cylinders.

Electrolabs Plants are in successful operation all over this Continent, both large and small installations. There is an **Electrolabs** Plant of just the capacity you need.

Consult with us about your needs. We are glad to furnish information to welders.

Electrolabs
ELECTROLYTIC GAS SPECIALISTS

Morris Bldg., Philadelphia, Pa.
Merchants' Exch. Bldg., San Francisco, Calif.

The Electrolabs Company

15 Williams Street, New York, N. Y.

General Office and Works: 2635 Penn Avenue, Pittsburgh, Pa.

Under the Technical Supervision of the Electrolytic Oxy-Hydrogen Laboratories, Inc.

No. 8-G for Natural Gas, $6.50

Preheating Blowpipes

The two most essential points in welding are:

FIRST: The use of a proper sized oxy-acetylene flame.

SECOND: The saving of gas by preheating your work for the oxy-acetylene flame.

The first is under your control in the use of the oxy-acetylene apparatus you have selected.

The second, we can aid you in by supplying the proper blowpipe for preheating purposes.

We manufacture blowpipes for use with Coal Gas, Natural Gas, Gasoline Gas and Acetylene Gas, with Air Blast.

Our catalog "B. X." free for the asking, contains full description and prices. WANT ONE?

Buffalo Dental Manufacturing Co.

Buffalo, N. Y., U. S. A.

Save 2 Hours Every Day

U. S.

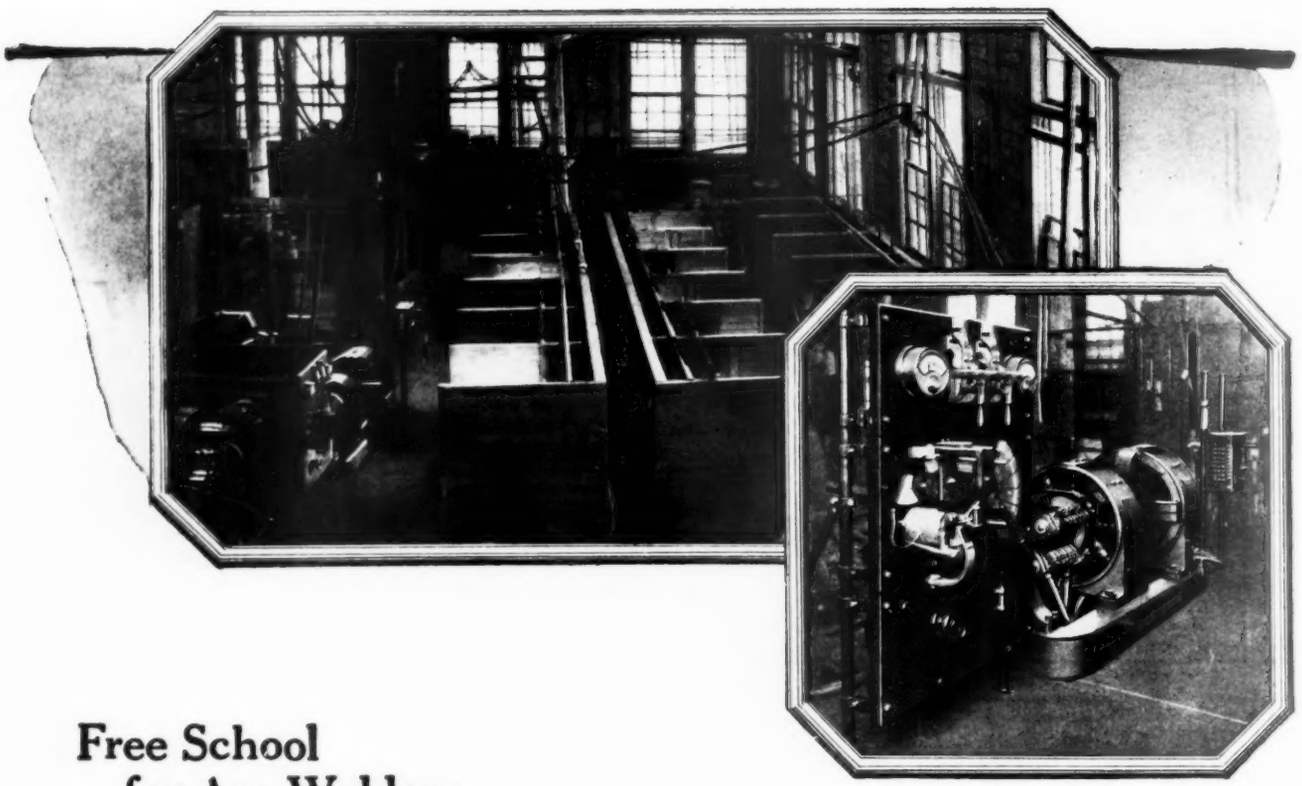
WELDERS MOULDING COMPOUND

Will do this — A post card will bring particulars —

UNITED STATES WELDING CO.

Minneapolis **Minnesota.**

Specialized industrial training eliminates mistakes that are costly in time and material.



Free School for Arc Welders

THE above illustration shows two views taken in the General Electric Company arc welding school at Schenectady, where courses are given in the following work.

Course 1: Repairs to steel castings.

Course 2: Repairs to iron castings.

Course 3: Repairs to steel plates and tanks.

Course 4: Recovery of broken taps and drills from castings.

Course 5: Welding of high-speed steel to low-carbon steel.

Course 6: Welding and cutting by carbon arc.

In from six to eight weeks men who have had no arc welding experience become efficient welders at the General Electric Company school in Schenectady.

Each student's record is kept and will be mailed on request to employer sending him to school.

This training is necessary as, unless operator holds a steady arc of uniform length, "cold welds" will be formed which will readily break open when subjected to a strain.

Dozens of prominent firms and departments of the U. S. Government availed themselves of the opportunity to have their men receive this exceptional training.

Instruction is free of charge to employees of those purchasing G-E arc welding equipment.

Send for Bulletin No. 48953 on Our Arc Welding School

43-254

General Electric Company

General Office Schenectady, N.Y.

Master Welders

Use

"Federal" Regulators

For Oxygen, Acetylene and Hydrogen Gases

Here's the Reason Why:

"FEDERAL" Regulators are made of the very best materials by expert mechanics for expert welders who know the value of and appreciate absolutely dependable Regulators.

They are passed by the National Board of Underwriters and their safety features make accidents to operators practically impossible.

FEDERAL BRASS WORKS

31st St. and Kedzie Ave. CHICAGO

Swift's Pure Oxygen

"A Reputation Imposes an Obligation"

Swift Oxygen must pass the most rigid tests —must never vary from its high quality standard.

Swift Oxygen is produced in the largest electrolytic plant in the U. S. A.—in ample quantities to render unequalled service to our customers.

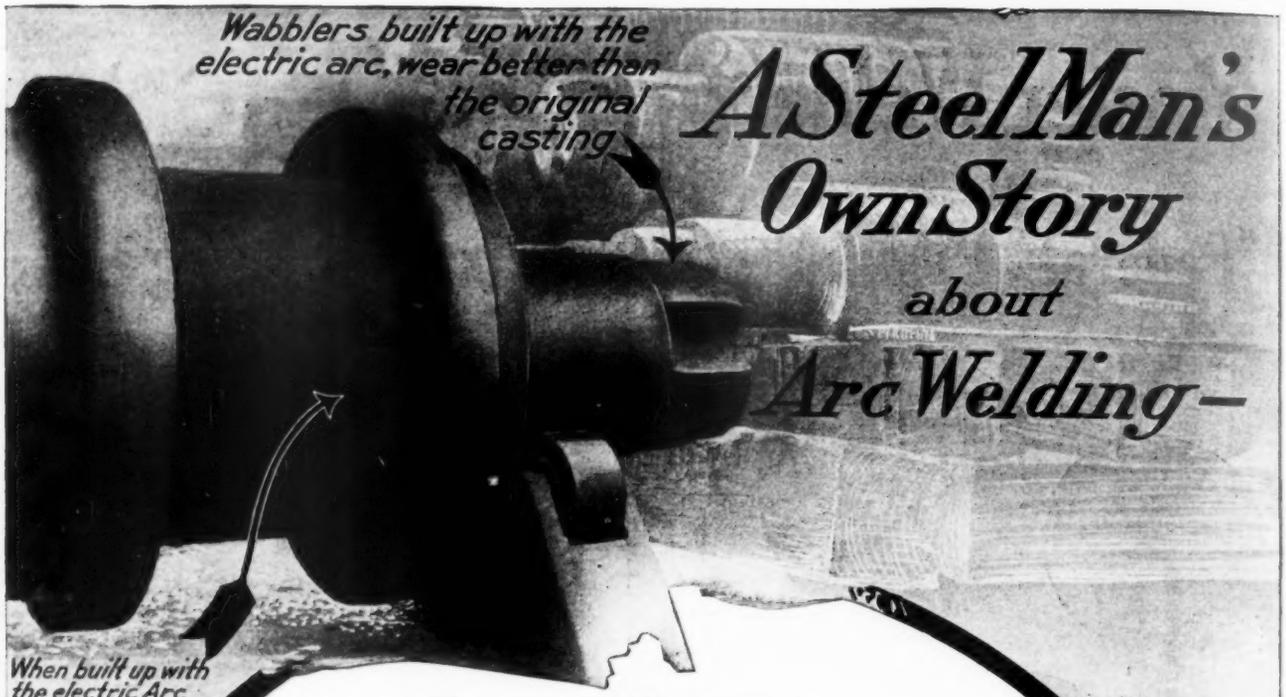
The use of Swift Oxygen in your plant will aid you in raising the standard of the work of your operators.

The Name is Your Guarantee

Swift & Company,

Oxygen Department

Union Stock Yards Chicago, Ill.


Wabblers built up with the electric arc, wear better than the original casting
When built up with the electric Arc the new surface will wear as well as the original material.

A Steel Man's Own Story about Arc Welding—

Can Save A Quarter Million Annually From the Scrap Pile—

"This is the first opportunity we have had in three years to give arc welding the attention it deserves," said a prominent Pittsburgh steel man.

"We are anxious, now, to push it to the limit, because we want to get every department on the most efficient working basis.

"We haven't been able to get men during the war, but now we expect to organize a welding department, as a branch of the electrical department.

"This department will be in charge of a good man, whose duty it will be to build up a well-trained welding force. It will be his duty to get the maximum good out of welding, and I know it can be carried much farther than it has because we have been limited by lack of time and a small force.

"I am sure the annual saving would exceed the quarter million mark."

The 42-inch roll shown above, was repaired at trifling expense in time and material. It would have cost more than $4000 to replace this roll.

The broad experience of Westinghouse Engineers is available to all who desire to give arc welding the careful consideration it deserves today.

You cannot expect good results from a welder that does not provide—
CONSTANT HEAT AT THE ARC
A good weld is absolutely dependent on a constant even flow of metal. This, in turn, is dependent on constant heat at the Arc.
Ask our Engineers about it.

Westinghouse Electric & Manufacturing Co.
East Pittsburgh, Pa.
375 *Sales Offices in All Large American Cities*

Westinghouse

This advertisement appears in the November, 1919, issue of The Welding Engineer

THE WIEDERWAX PREHEATER

Works Wonders For Welders

Showing A Panel Heater Just Being Finished

Very few welders care to do this class of work on account of the uncertainty of getting a successful job.

A **Wiederwax Preheater** makes it possible to get 100% efficiency on this class of work.

It makes the welding of these large flat castings as simple and sure as small ones.

Besides, there is more money in such work when success is assured.

HOW MONEY AND TIME WAS SAVED

This heater section was preheated in 30 minutes. It was covered with pieces of 20 gauge sheet iron, and was as hot on top as on the bottom.

The cost of gas was only one-fourth of what would have been the cost of charcoal.

The saving in the welder's time amounted to two hours.

There is no danger in cracking this kind of casting when preheated on a **Wiederwax.**

After it was welded it did not have to be buried to cool.

After welding was finished it was re-covered with the sheet iron, the gas burners turned off, and left on top of the preheater to cool.

The large bed of refractory material being red hot, it retained the heat for several hours.

Thus the casting cooled very slowly and evenly, making the contraction also slow and even.

What is true of this also applies to any other class of work where preheating is required.

Remember: There is no cracking of castings either in preheating or cooling on a Wiederwax.

Write for free booklet Department X.

GEIST MANUFACTURING CO.

2001 Atlantic Ave.

ATLANTIC CITY, N. J.

Sky high in QUALITY

CANADIAN CARBIDE

"More Gas per Pound"

CARBIDE SIZES

Medium	3½" x 2"
Small	2" x ½"
Nut	1¼" x ⅜"
Pea	¼" x ½"
Miners' Special	½" x ½"

Packed in

1000 lb. - 100lb
and 25lb *Drums*
10 lb 5lb. 2lb. 1lb.
Tins

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San Francisco, 427 Rialto Bldg.
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Belleville, Martha & Clemens Aves.
Benton.
Chicago, 549 McCormick Bldg.
Springfield, 812-814 E. Adams St.
INDIANA
Clinton.
Rochester.
Terre Haute, 15 N. Eighth St.
IOWA
Albia.
Centerville.
Knoxville.
KENTUCKY
Beaver Creek.
LOUISIANA
New Orleans.
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Duluth, Third Ave. E. & Michigan St.
Minneapolis
MISSOURI
Joplin, opposite Postoffice.
NEW JERSEY
Paterson, 61-63 Washington St.
NEW YORK
Buffalo, Seneca & Hamburg Sts.
Cortland, 41 Elm St.
Malone, 32-34 W. Main St.
Middletown, 28 W. Main St.
New York City, 30 Church St.
Roscoe.
Springville.
Trumansburg, 55 Main St.
Valley Stream.
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Barton.
Canton, 1372 Dueber Ave.
Cleveland, 3300 Lakeside Ave.
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Toledo, 928 George St.
Washington C. H.
Warren
Wellston
OKLAHOMA
Commerce.
PENNSYLVANIA
Altoona, 947 19th St.
Barnesboro, Philadelphia Ave.
Clearfield
Clymer.
Dagus Mines
Hastings.
Indiana
Johnstown
Kittanning
Latrobe.
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New Bethlehem
Philadelphia
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Pittsburgh, 1222 Farmers Bank Bldg.
Pottsville, Center & Market Sts.
Reynoldsville
Saltsburg.
Scranton.
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St. Benedict
Twin Rocks
Wilkesbarre.
Wilpen.
RHODE ISLAND
Providence, 546 Charles St.
TENNESSEE
Knoxville, 761 Asylum Ave.
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El Paso, 323 S. Santa Fe St.
Ft. Worth, 415 Throckmorton St.
UTAH
Salt Lake City, 121 W. 2nd South St.
VERMONT
Burlington, Park Ave
St. Johnsburg
VIRGINIA
Richmond, 1319 E. Main St.
WEST VIRGINIA
Charleston, 821 Virginia St.
Clarksburg, 603 Goff Bldg.
Huntington, 1023 Third Ave.
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Northfork.
Wheeling

CANADA CARBIDE SALES CO.,
INCORPORATED
WORKS
30 CHURCH ST. NEW YORK SHAWINIGAN FALLS, QUEBEC 549 McCORMICK BLDG. CHICAGO.

We Can Save You Money

ON

GAS AND OXYGEN

USE

WELD-A-CAST
Trade Mark
FLUXES

"Weld-a-cast" is a scientific combination of chemicals, that causes the metal to melt rapidly, shortening the operation, thus economizing in time, gas and oxygen.

"Weld-a-cast" adheres readily to the hot welding rod which picks up just enough and none is wasted; it does not blow away but melts at once; it eliminates blow holes and leaves the metal soft.

Write For Free Samples

CORTLAND WELDING COMPOUND CO.
CORTLAND, N. Y.

Will You Benefit From Others' Experience?

If a user of electric arc cutting and welding equipment you can easily acquire that benefit by ordering "Newarc" cables for your future needs.

"Newarc" Cables
are extra flexible,
positively do not absorb moisture,
unusually wear resisting
Will outlast all other cables in service.

The tough rubber cover serves as both insulation and outer protection. There is no inferior rubber insulation or exterior cotton braids to rot and fray out. Expensive and annoying tape repairs are practically eliminated.

Order a length now and gain first hand proof of these statements.

Immediate shipments from stock. Samples furnished upon request.

Electric Arc Cutting and Welding Co.

222 Halsey Street **Newark, N. J.**

Fluxes That Flux

Aluminum Welding
is difficult, in many cases impossible, without the aid of the correct flux.

Deebee Aluminum Powder
for Cast and Plate Aluminum and

Napolitan Flux
for Sheet Aluminum

Have been developed and are manufactured in the Davis-Bournonville laboratories.

These fluxes immediately dissolve the aluminum oxide, permitting the metal to unite, and contain no chemicals that will injure the weld.

Write for sample

WELDING AND CUTTING
DAVIS
APPARATUS
DAVIS-BOURNONVILLE CO. N.Y.

Davis-Bournonville Company
General Office and Factory
Jersey City, N. J.

Anti-Borax Welding Fluxes

It Pays to Use Only the Best

Better and stronger welds are more easily and more quickly made with Anti-Borax Welding Fluxes. That's real economy.

For Cast Iron, Brass, Bronze, Malleable Iron, Steel, Cast and Sheet Aluminum.

Anti-Borax Fluxes are scientific preparations which weld at lower heat, leave no scale, cleanse the molten metal, assist fusion and improve the quality of your work.

Anti-Borax Fluxes are the best that money can buy, yet they cost no more—usually less than inferior brands.

Guaranteed to give perfect satisfaction or your money refunded.

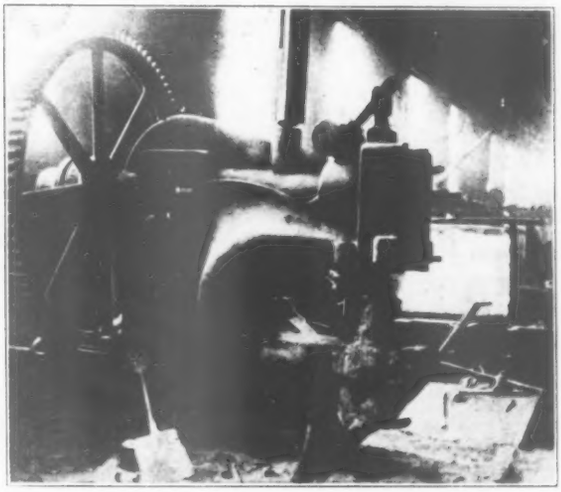
WRITE FOR PRICE LIST AND SAMPLE.

Anti-Borax Compound Company
FT. WAYNE, INDIANA

One of the innumerable instances wherein

THERMIT WELDING

proved to be the only dependable method for repairing heavy steel sections, such as



Housings, Shears
Crankshafts
Roll and Pinion Necks
Roll and Pinion Rods
Locomotive Frames
Drop Forge Equipment
and
Other Large Parts

The illustration shows a successful Thermit weld recently made on a cast-iron shear housing for the Independent Bridge Company, Pittsburgh, Pa., after a failure in attempting to weld the break by a brazing process.

The brazing process had consumed about three weeks in executing the weld. The shear was then installed, but it ran only a few hours when the housing broke again, through the portion brazed. It was then decided to repair the break by the Thermit process, which required only two eight-hour days, an additional half-day having been taken for stripping the mold.

The housing was quickly replaced in operation, as sound, if not sounder than ever and, at last reports, was back at its heavy work in cutting corners out of plates about $\frac{3}{4}$ in. thick and 3 in. square.

Remember that the only true test of a weld is the service test. The welding of a spare section proves nothing until that section has been installed and in operation for some time. Thousands of service tests have proved beyond question that Thermit welding is the only reliable method for repairing the heavy sections.

Send for Pamphlet 1779

METAL & THERMIT CORPORATION

120 Broadway, New York

329-333 Folsom Street, San Francisco
7300 So. Chicago Avenue, Chicago, Ill.
15 Emily Street, Toronto, Canada
1427-1429 Western Ave., Pittsburgh, Pa.

Factories located at Chrome, N. J., Wyandotte, Mich., East Chicago, Ind., Jersey City, N. J.

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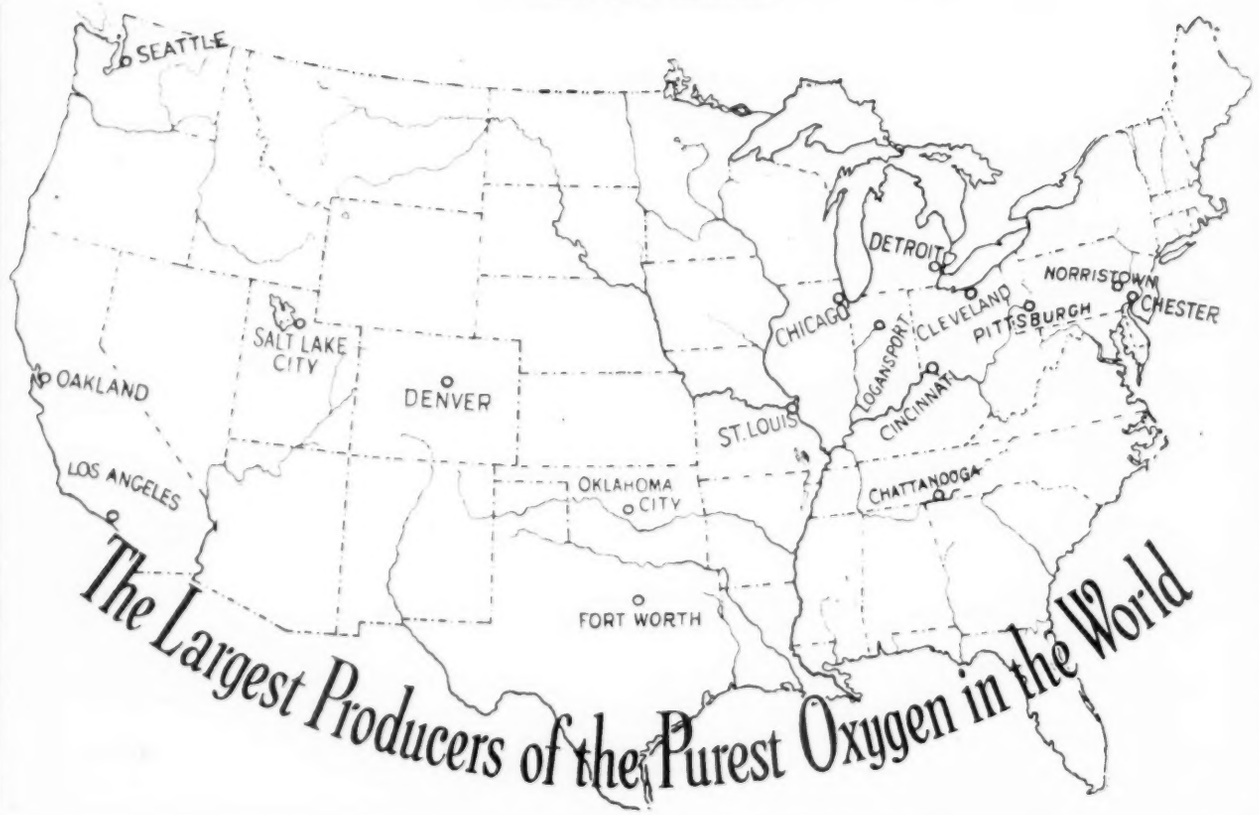

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The OXY-ACETYLENE INDUSTRY *in* FRANCE

By Major Paul Pleiss* and C. V. Price

As the last act of the organization that handled the procurement and distribution of non-toxic gases for the A. E. F. in France, a final investigation was made of the general condition of the oxy-acetylene industry in France. Naturally, in carrying out the functions of the non-toxic gas organization much information was obtained on the conditions existing but it was believed desirable to have a final resumé made. The major part of this survey was made by C. V. Price (then lieutenant) during the months of May, June and July.

The information was obtained from all available sources and there are certain to be minor discrepancies noticeable. All manufacturers and users of the process in France freely afforded every facility for the survey. Messrs. Granjon and Rosemberg† anxious, as always, to further the cause of welding and the close association in welding matters of the United States and France were of invaluable assistance.

The best general idea of the extent of use of the oxy-acetylene process may be gained from a consideration of the gas (oxygen and acetylene) producing facilities and it is proposed to take up this phase first.

Major Paul Pleiss.

Oxygen

The production of oxygen, that compressed into cylinders only, was, in 1914 before the outbreak of the war at the rate of 140,000,000 cubic feet per year with practically the entire amount produced by the liquefaction and separation of air. During the years 1916 and 1917 the greatest increase in production took place and at the end of 1917 it was estimated at the rate of 255,000,000 cubic feet per year, of which 84 per cent was produced by separation of the air and the balance (16 per cent) by electrolysis of water. The production capacity was but slightly increased during 1918, the production before the armistice was approximately at the rate of 275,000,000 cubic feet per year, divided, 85 per cent by separation of air and 15 per cent by electrolysis. The greater part of the production facilities added after 1915 were devoted to the production of munitions and as a consequence after the armistice the consumption dropped from the rate of 260,000,000 cubic feet per year in December to 160,000,000 in April. All of the manufacturers believe that as soon as industrial conditions in France are stabilized, the production will surpass the maximum reached during the war. The success attained by the oxy-acetylene process during the war has demonstrated many new uses that will be adopted for peace time industrial production.

The Liquid Air Company (L'Air Liquide) with main office in Paris is the largest producer of oxygen in France. The Claude process for the liquefaction and separation of air is exclusively used. Nine plants are now operated by this company, the plant at Lille was operated by the Germans during their occupancy of that city. Three new plants were installed during the war and the capacity of all plants was augmented. The Paris plant, for example, was increased over 350 per cent during the period of the war. Normally, before the war, this company produced from 50 to 60 per cent of the total oxygen used, during the war it supplied from 70 to 80 per cent of the total consumption. Plants are located in the following cities in France: Audincourt (near Belfort), Lille, Lyon, Marseille, Nantes, Paris (Boulogne-sur-Seine, suburb of Paris), Pont-Ste-Maxence and St. Etienne (near Lyon).

With the exception of Bordeaux district, the Liquid Air Company has plants located in all of the industrial centers of France. During the war this company was not only active in the production of oxygen and nitrogen, but produced acetylene, hydrogen, chlorine, caustic soda and other chemicals. The capital of the company is 15,000,000 francs and it is in a flourishing condition.

L'Oxylithe Company is the second largest producer of oxygen with three plants in Paris, and one at Roanne. The capacity of these plants is about 10 to 13 per cent of the total oxygen produced in France. The electrolytic process is used in these plants and the hydrogen production was disposed of to the French and American army for aeronautic purposes. Because of the demand for oxygen during 1916 and 1917 and the difficulty of meeting the demand due to cylinder shortage, Dr. Jaubert, the head of this company, designed a small liquefaction plant for installation at the works of the user. Up to the present time over sixty of such installations have been made in France, England, Italy and Spain. In capacity they vary from a production of 175 cu. ft. to 2,500 cu. ft. per hour. The oxygen production is from 98 to 99 per cent pure and in one installation made for the largest chemical company in France the average oxygen purity for over a year has been 99 per cent. The installation of these individual plants assisted in averting an oxygen shortage and was a satisfactory solution to the difficulty experienced by some of the larger users in securing ade-

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†Authors of Autogenous Welding and Editors of the French Acetylene Journal.

quate supplies of oxygen. It is understood that Dr. Jaubert has made arrangements to introduce his process into the United States.

P. Duffour Ignon Company, with plants at Bordeaux and Toulouse, produced about 9 to 12 per cent of the total oxygen production. This company is quite closely affiliated with Bardot, the Linde process for separation of air is used.

Bardot, with plants operating on the Linde system, has plants installed at Paris, Aubervilliers and Lyon. This company produced about 6 per cent of the total oxygen production.

Societe d'Oxygene et Azote (Oxygen and Nitrogen Company) with a plant installed at Montlucon produced about 3 to 5 per cent of the total oxygen produced. A modified Claude system with a Pictet rectification columne is used.

L'Oxhydrique Francaise (French Oxhydric Company) has a production capacity of about 3 to 4 per cent of the total oxygen produced. The electrolytic process is used exclusively in plants located at Trilport, Clamart and Villeurbanne.

Oxygen Purity

While no actual tests were made of oxygen purity some figures were obtained from users who had made tests, the purity averaged less than 97 per cent for liquid air oxygen and approximately 99 per cent for electrolytic oxygen. One user claimed that 94 per cent was the average for liquid air Oxygen.

Price of Oxygen

Before the war the price was approximately 9/10c per cubic foot at the factory, the user supplying the cylinders. During the war the price was raised to from 1c to 1¼c per cubic foot at the factory. It is believed that the price will be stabilized at the later figure. Considering that the users for the greater part own their own cylinders and pay transportation costs the price is higher in France than in this country.

Oxygen Cylinders

Many different sizes of cylinders are in use but the 235 cu. ft. size (7 cubic meters) is preferred and supplied in the largest quantities. Its height is 63 in., diameter 10 in., weight 165 lbs. with a wall thickness of about .3 in. The standard charging pressure is 2130 lbs. per square inch and the test pressure is 4267 lbs. per square inch. By governmental regulation, the maximum allowed charging pressure for oxygen, hydrogen and nitrogen is 2844 lbs. per square inch and all cylinders must be tested every two years to one and one half times the charging pressure. The cylinder manufacturers however usually test cylinders initially at twice the charging pressure or 4267 lbs. per square inch. Some of the U. S. standard 200 cu. ft. size cylinders are in service but the users prefer the larger size cylinder in spite of its disadvantages. Grey is the standard color for oxygen cylinders but during the war very little paint was applied. By decree of the Ministre of Railways, all cylinders shipped by rail must have a base flange to prevent rolling of the cylinder in transit.

Cylinder Turn-over

Before the war the average cylinder turn-over was seven times per year, during the war, due to the extreme scarcity of cylinders this rate was raised. The Liquid Air Company had an average cylinder turn-over of 100 times per year and most of the other companies averaged nearly as high. The manufacturers believe that this rate of turn-over can be maintained during peace times.

Cylinder Valves

The most widely used types of valves are the Draeger and the Titan, both with forged bronze body and iron handwheel. A standard female outlet is used which has a diameter of about ⅞ in.

No safety vent is provided on French valves and in spite of this there is no record of an explosion of an oxygen cylinder. Because of the shortage of bronze, attempts were made, principally in Germany, to use steel for oxygen valves but they were not successful due to the rusting of the valve parts and excessive leakage. The prices for valves correspond quite closely to the prices prevailing in the United States. Valve protecting caps are used on all cylinders.

Acetylene

The use of dissolved acetylene in France is not as general as in the United States. It is estimated that the consumption during the peak period of 1918 was not more than at the rate of 30,000,000 cubic feet per year. Approximately 175,000,000 cubic feet of acetylene per year was generated by the user. The extreme difficulty of securing a supply of cylinders undoubtedly held back the development of the use of dissolved acetylene in connection with the oxy-acetylene process.

Dissolved Acetylene

Practically the Liquid Air Company through its own factories and ownership or control of subsidiary companies has a monopoly of the supply of dissolved acetylene. Ten plants located at Paris, Champigny, LeHavre, Lille, Lyon, Bordeaux, St. Nazaire, Marseille, Audincourt Liege (Belgium) are owned or controlled by the Liquid Air Company. The production of these plants embraces approximately 85 to 95 per cent of the total production facilities in France.

In practically all of the Liquid Air Company plants a simple hand feed low pressure acetylene generator is used. The generator is equipped with a rising bell gasholder to give generation flexibility and prevent excessive pressure developing within the generator. All sizes of carbide can be used. At intervals, calculated to keep the bell of the generator at a reasonable height, carbide is shoveled into the generator, 15 lbs. at a time. The water capacity of the generator is about 35 cu. ft. or 230 gallons. Catalysol is used as the purifying agent.

L'Oxylithe Company has plants for filling acetylene cylinders at Paris, Roanne and St. Etienne. Their production facilities are about 7 per cent of the total of France.

Societe des Appareils Magondeaux has one plant located in a suburb of Paris with a production capacity of about 5 per cent of the total production in France. A handfeed generator is used with Heratol as the purfying agent for the the acetylene. Two 210 cu. ft. per hour Thiron compressors are used. Compagnie Generale d'Acetylene installed an acetylene compressing station in 1914 at La Corneuve, a suburb of Paris. The plant has a production facility of say 2 per cent of the total production in France. This company's primary object is the exploitation of the Dalen patents (A. G. A.) for signal lights, bouys and train lights. Two Dalen automatic generators are used for the generation of acetylene. The compression is carried out with three Dalen compressors with a compression capacity each of 359 cu. ft. per hour. Heratol is used as the purifying agent for acetylene.

Price of Dissolved Acetylene

The general price of dissolved acetylene during the war was from $36.40 to $44.80 per 1000 cubic feet, based on carbide at say $80.00 per metric ton. The opinion of the acetylene users is that with a lowering of the price of carbide from its price during the war a corresponding reduction will be made in the price of dissolved acetylene. It is expected that carbide prices will be decreased to from $50.00 to $60.00 per metric ton and the price of dissolved acetylene will be from $28.99 to $30.00 per thousand cubic feet. As in the case of the use of compressed oxygen, the user of dissolved acetylene for the most part owns his cylinder requirements and also bears the cost of transportation. The price may therefore be considered as being slightly in excess of the prices prevailing in the United States. The manufacturers of dissolved acetylene feel that there will be a large increase in the demand as soon as sufficient cylinders can be procured. Conditions favor a wider use of dissolved acetylene, the distances for transportation are much less than

in the United States and medium pressure generators can not be used in France.

Purity

In spite of the lower quality of the carbide supplied during the war, the purity of the acetylene was equal to that supplied to users in the United States. The purity was maintained by the manufacturers by great care in the use of purification material.

Acetylene Cylinders

Before the war the manufacturers of dissolved acetylene were prevented, by Governmental decree, from filling cylinders to a pressure greater than 142. 2 lbs. per square inch (10 Kgs. per square centimeter). During the war the limit was officially raised to 170 lbs. per sq. in. but generally cylinders were filled to 213 lbs. per sq. in. It is expected that the French Government will shortly officially permit cylinders to be filled to 213 lbs. per sq. in. (15 Kgs. per sq. cm.).

There are no restrictions as to the methods of manufacture of cylinders except that the completed cylinders must stand a hydraulic test pressure of 853. lbs. per sq. in (60 kgs. per sq. cm.) which is prescribed and witnessed by the Government. Practically all cylinders have the top, bottom and lengthwise seam welded by the oxy-acetylene process. They are filled with the porous mass through the valve opening. The Government conducted tests must be repeated every five years on each cylinder. A hydraulic test is required and the manufacturers are attempting to have the regulations changed to a test every ten years that may be carried out with gas pressure instead of hydraulic pressure. The hydraulic test is opposed by the manufacturers who use the concrete-like filler because it means taking out the porous mass which is of course difficult without destroying the cylinder.

There are no governmental restrictions regarding the use of brass or copper in acetylene valves but Paris and most of the larger municipalities have prohibited its use for this purpose.

Various sized cylinders are used in France, ranging in capacity from 70 to 250 cu. ft. of gas capacity. The size preferred is one containing 141.2 cu. ft. of dissolved acetylene (4 cu. m.) at 213 lbs. per sq. in pressure. Most of the new cylinders being put into service are of this size.

Cylinderr Prices

During the war the prices paid by the A. E. F. for the 141.2 cu ft. cylinder averaged about $90.00 each. This included the complete cylinder with porous mass and the initial charge of acetylene.

Acetylene Cylinder Valves

An iron valve is used that resembles the type of valve used in the United States for medicinal oxygen and nitrous oxide cylinders. There is no threaded outlet connection but a yoke and screw is used to hold the regulator connection in place. The valves are not equipped with a safety blow off nor are fusible plugs used on the cylinder.

Porous Mass for Acetylene Cylinder

The various manufacturers of acetylene cylinders use different porous masses for their cylinders.

The Liquid Air Company, uses solely the hard, long-baked, concrete-like porous mass that is introduced into the cylinder as a thick paste composed of Kieselguhr, zinc oxide, zinc chloride and fibrous asbestos. The material is very similar to the Dalen material used by the Compagnie Generale d'Acetylene and by the Commercial Acetylene Company in the United States. The material is put into the cylinder through the valve opening by hand, women being employed for this work. While being filled with this mass the cylinders are bumped for eight to twelve hours by an automatic 4-inch drop that holds ten cylinders at a time. This bumping of the cylinder during filling insures all of the material settling into a compact mass without open spaces. The filled cylinders are baked for from seven to eight weeks in a coal fired dryer at a temperature of about 550 degrees F. the temperature is gradually raised to this point during a two-week period.

The purest acetone obtainable is used as a solvent in the completed cylinder. It is introduced into the cylinder under air pressure up to 280 lbs. per sq. in. The air pressure is varied depending upon how readily the acetone is taken by the porous mass.

For charging the cylinders with acetylene, Thiron compressors are used, the cylinders are charged in an upright position. Each cylinder is weighed each time it is returned to the factory for filling, a numerical cylinder record is kept showing the amount of acetone added to individual cylinders. The acetone loss per cylinder averages about 1.4 per cent by weight for each filling. Charging of cylinders is usually carried out during a ten hour period. The pressure is gradually raised from zero at 8 a. m. to 170 to 195 lbs. at 6 p. m. The cylinder is then given another charge to 284 lbs. and taken off the line. In the morning the pressure is found to be about 170 to 185 lbs. per sq. in. and the cylinder is ready for shipment. Water is not used to cool the cylinders during charging and because of the relative slowness of the charging there is but little rise in the temperature.

The Compagnie Generale d'Acetylene use practically the same filler as the Liquid Air Company and their factory proceedure both as to manufacture of the cylinders and charging is quite similar. In both cases welded cylinders are used.

Societe des Appareils Magondeaux uses as a porous mass a mixture of Kapok and raw silk. This company has adopted as standard the 140 cu. ft. cylinder with the following weight:

Cylinder, valve and porous mass	66.5 lbs.
11⅓ litres of acetone	19.75 lbs.
Acetylene	9.9 lbs.
	96.15 lbs.

The regular practice of the Magondeaux Company is to charge three times, the first for 2½ hours to 213 lbs. per sq. in., the second from 2 to 2½ hours at say 250 lbs. and the third and final charge to 240 to 260 lbs. for 2½ hours. Between each charge a period of twelve hours elapses. Welding size cylinders are not weighed for acetone loss until the fifth time they are returned for filling. The porosity of the Magondeaux mass is claimed to be between 60 and 70 per cent.

L'Oxylithe Company uses a porous mass somewhat similar to that used by Magondeaux and the factory procedure is not different.

At the present time no manufacturer in France is using a pure asbestos filler for acetylene cylinders.

Champy Freres have developed a filling material that appears to have considerable merit. The material is a special charcoal mixture prepared from certain woods and under closely controlled temperature conditions. The finished product is ground to the proper size and is introduced into the cylinder through the valve opening. The cylinder is bumped during the filling operation but no binding material is used with the mass. The addition of acetone causes the mass to swell and occupy all free space. The finished cylinder is claimed to have a porosity of from 77 to 80 per cent.

The acetone loss is claimed to be not more than one-half of one per cent by weight per filling. The filling material has the advantage of low cost and high porosity. It has been used with considerable success in the past in England, Belgium and Germany.

Generator Acetylene

The pressure in common practice in modern French acetylene generators is from six to ten inches of water pressure (say six ounces) in the older types from four to six inches of water pressure. The best known and most widely used types of generators are the Javel S. A. F. L'Hermite and the Ledoux. They are all carbide to water type and take all sizes

of carbide. About forty per cent of all welding work is performed with acetylene generated in these standard generators. About twenty per cent of the welding work done in France is performed with acetylene generated in portable and "freak generators," twenty per cent is carried out with foreign made generators and the balance with dissolved acetylene. The larger installations are well planned and operated. In nearly all cases a purifying agent is used for the acetylene, Catalysol is more widely used than any other purifier.

Carbide

Prior to 1914 the manufacture and sale of carbide in France as in all other European countries was controlled by a syndicate composed of all manufacturers in England, France, Germany, Italy, Switzerland, Norway and Italy. The war broke up the syndicate so far as its control over other countries was concerned, but in France the remains of the French end of the syndicate still controls the market. The production of carbide in France in 1914 was approximately at the rate of 45,000 tons per year with the following distribution of consumption.

160 village installations	5,000 tons
40,000 private lighting plants	20,000 tons
Mine lamps, dwelling lamps, flare lamps, automobile generators and other uses	10,000 tons
Oxy-acetylene welding, generator acetylene	7,000 tons
Dissolved acetylene	3,000 tons
	45,000 tons

Serious restrictions were placed on lighting during the war and the excess supply of carbide caused by this decrease of consumption was absorbed by users of the oxy-acetylene process.

During 1916 the consumption of carbide by the oxy-acetylene process was estimated at the rate of 26,000 tons per year. The French carbide manufacturers were not able to materially increase the production capacity of their plants and to overcome the shortage large importations were made from Switzerland and a lesser quantity from Spain.

During 1917 the carbide used by the oxy-acetylene process rose to the rate of 30,000 tons per year. In 1918, due to the completion at that time of the major part of the construction work of chemical plants, the consumption fell to the rate of 25,000 tons per year.

The production capacity of the French carbide plants was in 1919 at the rate of 50,000 tons per year. It is the general opinion of the manufacturers that as soon as conditions in industry are settled that the demand for carbide for welding purposes will be at the rate of 15,000 to 20,000 tons per year and will show a steady increase from year to year over those figures. Messrs. Granjon and Rosemberg believe that the oxy-acetylene industry will be enormously developed during the coming year. They ascribe their opinion to the fact that many manufacturers have learned of the possibilities of the process through its use for munitions work.

Nearly all of the carbide used during the war was of the class known as "tout-venent," that is all sizes, from small particles to the largest lump. Before the war the carbide was divided into two general classes, broken and granulated but there was always a mixture of the two classes in all carbide purchased. There is no dust for sale, all dust being briquetted. The quality of the carbide, at least during the war, was such that it was necessary to use purifying material in connection with acetylene generators. The carbide is supplied in various sized metal containers, similar to those used in the United States.

Price of Carbide

The price adopted by the French Government for carbide was 94 francs per hundred kilograms or roughly $80.00 per ton. The price before the war was from $50.00 to $60.00 per ton. Indications are that the average price will be in the neighborhood of $70.00 per ton.

Carbide Distribution

Carbide is distributed from 175 warehouses and depots located in the principal cities of France. The sale of carbide is entirely in the hands of the Societe Commerciale de Carbure with headquarters in Paris. The company is made up of subsidiary companies and eight plants for the manufacture of carbide are operated.

Welding Practice

The low pressure torch is used to the extent of about 75 per cent of all welding operations. The Picard type, manufactured by a subsidiary company of the Liquid Air Company is the most widely used torch. The same company manufactures a medium pressure torch for use with dissolved acetylene. The prices of oxy-acetylene apparatus in France are a great deal lower than prices in the United States and the equipment does not appear to be as efficient or to be as well constructed.

During the war most of the welding work was performed on iron and steel and the welding of other metals has been to a certain extent neglected. The principal application for the process has been in the manufacture of bombs although the manufacture of pressure containers and airplane motors was of large importance. Women have been used to a great extent as welders and have been a marked success. A new method of torch manipulation called backward welding has been developed that promises an increase of about 20 per cent in speed of welding. This new method will be described in a later article.

Important Users of the Oxy-acetylene Process

Practically all of the industrial firms in France used the process to a greater or lessor degree but the following are the largest users. A. Girel, Paris, manufacturer of bombs and pressure tanks. During the Summer of 1918 this firm had nearly fifteen hundred welders employed in its five shops located in Paris. Since the armistice its activities have been greatly curtailed but an effort is being made to adapt welding for use in the construction of tank cars for the transportation of wine and other liquids. Aluminum tanks made of 3/8-in. metal, six feet in diameter and twelve feet long have been constructed. Many of the tanks after manufacture are glass enameled on the interior.

A. Girel was by far the largest user of the oxy-acetylene process in France and intends to adopt his war time experience to peace time activities.

The Renault Company is the largest automobile manufacturer in France and is famous for its trucks and tanks built during the war. Approximately two hundred welding stations were in use by this company, principally for the manufacturer of airplane motors.

The Citroen Company had fifty welders continuously employed on miscellaneous work. This company is one of the largest in France, but during the war devoted its attention almost entirely to the manufacture of shells. A small automobile is to be produced by this firm in the future, the first year's production to be 30,000 cars which is an unheard of figure in French automobile production. Undoubtedly the use of the oxy-acetylene process will be extended.

Thomson-Houston, the General Electric Company of France, were engaged largely in the production of munitions and employed slightly over one hundred welders for this work.

A great many other industrial firms employed from twenty to sixty welders during the war and the outlook for the continuance of the use of the process is bright.

Summary

The size of oxy-acetylene industry and the extent of use of the process is not as far advanced in France as in the United States. It is doubtful if there are in the United States any men better qualified in the laboratory phases of the process than Messrs. Granjon, Rosemberg and the assistants that

have collected. Their efforts have been directed towards the dissemination of knowledge of the process but it has been harder to convince manufacturers in France of the merit of the process than was the case in the United States. Individual workmen have become highly skilled, particularly in heavy aluminum welding but it is believed that the great body of welders in France do not measure up to the American standard. The resources of our country have permitted the process to grow much more rapidly than has been the case in France. Our efforts have been entirely towards putting the process on the broadest commercial basis of utilization and the finer work, the laboratory phases of the process have, to a certain extent at least, been neglected. The superiority of American made apparatus is quite apparent but the French feel that if their prices were placed at the level of the American prices the use made of the process would be curtailed. One remarkable fact stands out clearly as a difference between conditions in France and conditions in this country and that is the degree of co-operation that exists between the manufacturers, the users and the French Welding Society. All of the manufacturers of apparatus are united in their efforts to further the use of the process through the offices of the Welding Society and this spirit has been of tremendous import to the growth of the industry in France. The lesson should not be lost on the manufacturers here.

CAST IRON WELDING

Editor:

Just a few things to say about cast iron welding, as I think it is one of the most difficult metals there is to weld.

The reasons why: first, it is very hard to weld without getting hard spots and make welds that are not machinable. Second, it is a hard metal to control in a molten state without the aid of carbon blocks or paste. Another thing it is hard to keep blowholes out of it. Then there is the difficulty of preheating cast iron so as to not leave stress and strains and so that they are not full of small checks when they come out of the fire. Then there is the warpage to think about, which is a very important item, as many garage and automobile men condemn welding of cylinder blocks for this reason. One reason is the warpage caused by overheating or not heating enough causes them a lot of trouble.

Now I would tell how to overcome some of those difficulties. First, in order to have welds that you are able to machine you should have a tip large enough to make your metal flow instead of just bubble, as that is one of the great faults of so many welders, they do not get their metal hot enough so as to melt it and float the dirt to the surface, as by floating the dirt to the surface you eliminate pinholes, which is impossible when the dirt stays on the bottom. By using small tips the heat is so local that it cools in the line of the weld so rapidly as to cause hard spots. By using big tips you can work faster, have better penetration and softer welds, as with the small tip the penetration power is very poor.

You will find men who use a number four or five tip for welding cast iron up to three-quarters of an inch. They V out their metal and then their tip has not enough heat to get the bottom of the V hot, so they just lay the rod in and melt it off. The average welding shop will find lots of jobs come in broke in the weld that remind you of the "Plasters Union"; some of their welds you can knock off with a cold chisel.

There are men who think that the word autogenous welding means that they don't have to dig any dirt out of the bottom of the weld. They seem to think that the only use the filler rod has is to be melted away. They forget that they could use it to dig out the dirt at the bottom of the weld which causes the blowholes. Then there are times when they could use the rod as a dam when the metal starts to flow over the edge.

Now I would say I do not believe in V'ing out metal up to three-quarters of an inch thick, as there is an advantage in melting the metal out instead of grinding. First, say we had a piece of cast iron a half an inch thick; it has been on some machine where there was a lot of oil and as the cast iron is very porous it absorbs the oil, as you have noticed many times. You start welding and as the metal fuses at the bottom you find blowholes form. You dig down but still no dirt, but when the metal sets it is full of small pinholes all the way up from the bottom. That is caused from the porous metal absorbing oil while on the machine. The heat from the torch starts to evaporate the oil contained in the casting as the gas goes up in order to escape. Now in order to overcome this the metal has to be hot enough so as to burn the oil out of the casting before the weld is started. That is why it is best to use a large tip and melt the V out instead of grinding. Do not burn it out with an oxidizing flame, but melt it out with a neutral flame, as in doing so your heat has penetrated far enough from the line of weld so that the fumes have escaped by the time you have started to fuse your metal. Now you have been less time melting it out than you would have had you ground it and then you've got the heat already there, where if you had V'd out you would had to play the flame on the casting just as long in order to burn the oil out. And another advantage is it saves time and as you all know time has a value in the commercial shop of today. Of course you might use a bit more gas, but you more than make up for it in better welds and the saving of time.

Then for the hard spots. You most always find them right on the edge of the weld, caused from the welder pushing all the sand and dirt from his weld out to the edge and never taking it away. The way to overcome the hard spots on the edge is to fuse the metal along the line of weld floating the dirt up.

Now this is my method of handling the most of cast iron work, and I find that I have good success making cast iron welds.

Now a little matter about torches. I know of two torches I could recommend to the welder that he would be able to use and be sure and get penetration, also that would stand the heat without flashing when you put them in a hole or a difficult place. That is one reason why so many men have to waste time in grinding out their castings as their torch will not stand up long enough to let them melt out their V, as the minute that a small particle of dirt or metal flies and hits the tip causes it to flash. Now it is not only an aggravating occurrence but is a waste of time to have a torch doing that. If you would stop to think of the time lost in shutting off and relighting a torch that is constantly backfiring you would be much further ahead to throw away your old one and invest your money in the best that money can buy and save yourself a whole lot of cursing, also a good many dollars. A man can make a good torch pay for itself in a short time through its efficiency to last through one job after another without backfiring. So don't forget that it is better to pay a little more and get a torch that will stand up under all conditions as it will save you much time and gray hair.

Would like to have more writers to give their ideas on the welding of cast iron through The Welding Engineer.

D. J. Matelski.

NEW ITALIAN WELDING PAPER

With the assistance of the French Acetylene Association a new welding journal is to be established in Italy. The new paper will be the official organ of the Italian association.

THE INDICATION *of the* RATE *of* FLOW *of* GASES

A Most Evaded, Though Important Factor

By Rudolph L. Hanau, M. E.*

THE torch is that part of the welding and cutting apparatus which serves to mix oxygen and combustible gas. The combustion of the escaping mixture of gases supplies the heat for welding and cutting respectively. In part, the gases may serve to accomplish chemical and other physical requirements.

The most efficient torch equipment is that which performs its allotted duties with a minimum of cost. The initial expense of the equipment, though important, should *not* be the sole determining factor.

The cost of operation comprises: general expenses (overhead, rent, transportation, amortization, etc.), maintenance, material (gases, metal, flux, etc.), supervision, labor, and lastly spoilage and waste. All these items, with the exception of the first mentioned, are understood to be shop expenses proper. It is intended to show how time and expenses can be reduced to a minimum, and how quality of the work can be improved and its quantity increased by intelligent application of apparatus.

It is in the interest of the torch users, to be supplied with means, to cut down to a minimum the waste of time, gas and material, and it is the aim of the torch manufacturer to provide such means.

At present there does not exist a perfect all-round torch, or torch equipment, and, in consequence, there cannot be an all-the-time perfect operator.

The line of perfection is approached asymptotically, and we must not expect an exception of the progress in the welding art.

So many variables handicap welding and cutting operations, that it would be unreasonable to expect 100 per cent perfection of a torch, or of an operator.

The capital variables are:

1. Composition and distribution of the gases.
2. Composition and distribution of the treated material.
3. The equipment.
4. The human element.

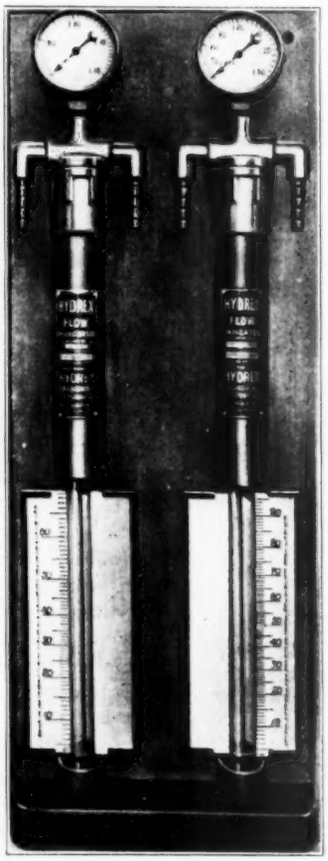
The nomographist may tabulate, dissect and extend these variables repeatedly and, as a result, he will enjoy a graph, that very accurately resembles the family tree of the most blue-blooded aristocrat.

To check, control and reduce these variables is progress. We may observe this in the progress we have made to date. We have learned to recognize very fine differences in composition and distribution of the material to be treated, and also in variations of purity, mixture and quantity of the gases used. We are able to give consideration to temperature, time, pressure, uniformity, etc.

Few of these requirements are within absolute control of instruments, none within that of judgment. Consciously or unconsciously we employ instruments, and for no other reason than to reduce the application of judgment, good or poor.

The writer, during his long shop experience, has often observed, that good judgment was founded upon caveman erudition, instead of upon cold facts and experience only. But no matter how solid the foundation of "good judgment" may be, the human element that controls judgment is, as a rule, not as reliable as the parts and mechanism that make up even fair instruments responding to potentials, space and position.

In the foregoing the writer very cautiously tried to impress upon the torch user the imperative necessity that he should employ besides pressure gauges, pressure regulators, valves, etc., a gas flow indicator. This is an instrument which indicates the rate of flow of the operating gases. It enables the operator to obtain such quantitative and qualitative composition of the gases, as authorities and instructors, as well as his own experiences teaches him to apply.



Hydrex Flow Indicator
Fig. 1

The manufacturer, of course, is desirous to produce a torch and tip that has definite capacity and effectiveness. He at present carries on experiments, investigations and tests to obtain that goal. For him it is the most important to possess reliable and convenient instruments in his laboratory.

In the testing laboratories, of our most advanced manufacturers, it is customary to determine the rate of gas consumption by meter and time observations. While there is no objection to such method, it must be admitted by those practicing along these lines that it is a laborious method, and if not very cautiously manipulated, none too accurate.

The meter method is not applicable to the shop of the torch manufacturer or operator. It is too elaborate and complicated for the welding shop, and too "slow" for quantity work in the machine shop. Some manufacturers are said to submit each torch and tip to practical test, which is of course an excellent procedure if done properly and conscientiously.

We were not told whether these tests were carried to an extent to verify *all* claims which accompany the torch equipment.

To the writer, it seems unreasonable to expect the manufacturer to make too extensive tests on all implements with his present equipment. It is particularly referred to those items which concern gas consumption and gas mixture, both of which are the capital requirements of satisfactory and economic welding.

Innumerable pages in the welding and cutting literature are devoted to the subject of gas consumption and gas mixture. We are told such and such shall be the mixture to obtain certain results, or we are taught in negative terms, i. e., what not to do.

All authors seem to agree on the principle defects and short-

*Consulting Engineer of the Hydrate Engineering Corp., Buffalo, N. Y.

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GOOD welding shops are an asset to any community. They should be encouraged and helped. The Editor of The Welding Engineer will be glad to have information and photographs relating to any successful job welding shop.

This page is intended to be a directory of America's best shops. The cost of advertising is low. Write for details.

comings, none command, or advise to measure the rate of flow of the gas with a flow indicator, as they do advise to measure the pressure with the pressure gauge.

This deplorable state of affairs exists, not because our well meaning and learned advisors do not know how to measure the rate of flow, but because no conveniently applicable flow indicator was at their disposal.

The determination and direct indication of the flow of gases is one of the most interesting though complex problems. It was practiced by physicist long before the engineer made use of it in the shop and laboratory.

The principle devices, for direct and continuous indication of the rate of flow of gases, are devices responding to

1. *Impact* of the moving gas masses.
2. *Differential pressure* about a constricted section of a pipe line or duct conveying the gas.
3. *Change of area* in the pipe line.

The first two methods employ liquid columns or floats (but not necessarily) to indicate the increasing rate of flow by an increasing differential pressure.

The third method is a "dry" method being actuated by constant differential pressure.

All three methods are equally convenient and reliable. The Pitot Tube and its modifications are the representatives of the impact method. They should not be used in very small lines or for too low velocities. Method 2 refers to the nozzle, orifice and Venturi principle. The latter devices are applied as frequently as the Pitot Tube in shops and laboratories as well.

Combinations of method 1 and 2 are employed where great accuracy is demanded. Method 3 has long been used for measuring minute quantities of flowing gas, as well as for gauging large volumes of air, such as are supplied to steel furnaces.

The gas is conducted through a tapering conoidal tube, within which floats a plunger; the position of this plunger bears a definite relation to rate of gas flow.

The apparatus illustrated in Fig. 1 represents the "dry" type. This principle was selected for development for the welding and cutting line, because of its simplicity and foolproofness.

Fig. 2 shows a diagrammatical section of apparatus. The gas enters the inner chamber (c), through nipple (a), thence flows through taper tube (d) upwardly and escapes through nipple (b). A plunger (e) floats within (d).

The gas passes through the annular orifice around plunger (e); the greater the flow, the higher the plunger (e) is lifted by the stream of gas.

The disc (f) is suspended by a rod from the plunger, is visible through the glass tube (g) and associated with a scale calibrated in cubic feet per hour, reduced to normal conditions for a gas flowing at a definite pressure and definite temperature.

The gas at the time it is measured, may flow at a known pressure and a known temperature, which do not coincide with those for which the calibration is prepared. In such a case we have to convert the reading into the proper volume, by applying those formulas which govern flow of gas through orifices.

These calculations, of course, should not be necessary for a conveniently applicable apparatus.

The elimination of computations is accomplished by the use of a chart, which permits the conversion of a reading for any pressure and temperature.

The use of a chart is practical in the laboratory where close observation and intelligent interpretation of the chart may be expected. For the ordinary shop work it is quite out of place.

Of course, some of the problems mentioned belong to the laboratory and it may require instruments of short range but widely spaced calibration of the volume units. Laboratory instruments are combined in sets of four, each instrument commanding a short range overlapping that of the adjacent in capacity. Such laboratory sets are a necessity in a well equipped laboratory, but not practical for the shop. For shop use the ordinary commercial instrument (such as shown in Fig. 1) more than suffices.

To make the instrument a practical and convenient shop and an all-around test apparatus, it was necessary to simplify the determination of the volume passing through the flow indicator. A pressure gauge has been added to the instrument. This pressure gauge indicates factors instead of pressures in pounds per square inch. The reading on the flow indicator scale, multiplied by the factor, is the actual volume of gas, reduced to normal conditions, passing through the flow indicator. Thus, the shop operator is relieved of all complicated mathematical

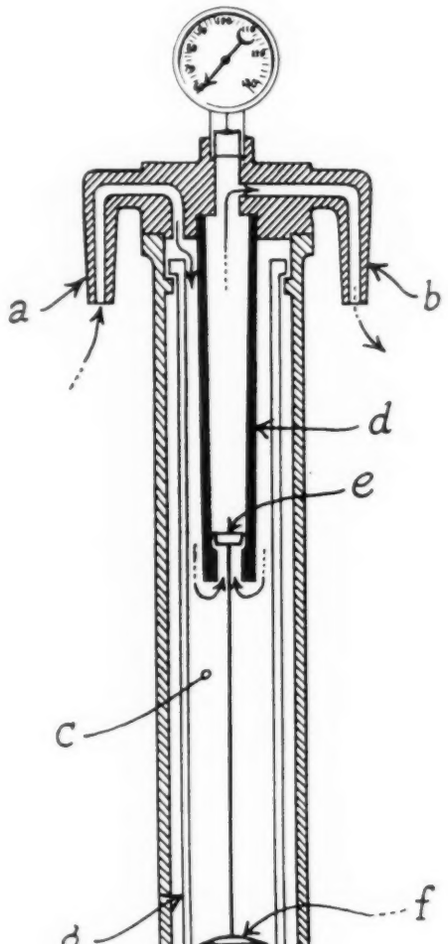

Fig. 2

considerations and he may concentrate his energies upon his work.

The influence of the temperature upon the readings is approximately, 1 per cent for each 10° F.

The influence of the pressure upon the volume is inverse to that of temperature, increasing temperature *decreases* the density of gas, while increasing pressure will *increase* the density.

On a calibration made for 40 lbs./in.² gauge pressure, the increase of one pound in pressure compensates for an approximate increase of 10° in temperature; and if the calibration is for 10 lbs./in.² gauge pressure, an increase of ½ lbs./in.² pressure will compensate for an increase of approximately 10° F.

As a matter of fact, too little or no attention had been given volumetric determination in the shop during the past. Never-

needless, every user of torches does acknowledge that proper mixture is the backbone of good welding.

Correct mixture decreases the cost of items enumerated in the beginning, i. e., maintenance, material, supervision, labor, spoilage and waste.

It need not be argued that the sparing of apparatus, the saving of gas and welding material, the reduction of time for supervision, getting ready and operation, and finally the accomplishment of better and more uniform work, are savings in cost of application. The advertisements and catalogues in substance point in that direction.

To the torch user in general, it is quite immaterial whether he achieves results by high or low, by equal or different pressure gases; he only counts convenience, economy and results.

The manufacturer is handicapped in many ways, the greatest handicap being the fact that the majority of his apparatus is shipped to customers with whom he cannot remain in personal contact. The apparatus no matter how perfect, may reach very inexperienced, though well meaning individuals. The consequences are too well known.

In most cases it may be expected that instructions which accompany the torch equipment are carefully studied. The stumbling block always is the mixture regulation. Instructors and demonstrators with excellent experience, seem to fall short of leaving definite and lasting evidence of their endeavor with their students.

As soon as the novice or student is left alone, he usually begins to muddle along with a flame that passes *his* judgment, and as a result it must be expected, his labor is imperfect. Why should it be otherwise? The pieces stick together and the job does not look so bad after all—on the surface at least. Shortly after the job comes back to the welding shop, for reasons we may guess. But that does not matter much; it is simply done over again by the artist himself or a brother artist. The latter may, or may not, be a good welder himself, nevertheless, he will feel obliged to call attention to the foolish way the other fellow did the job, and how the work should have been done, and the victim may not, or may suffer another disappointment. It's happy-go-lucky for both the welder and the customer.

And why is all this uncertainty? For no other reason than the fact that the flame the welder needs is beyond control of judgment alone. The intensity and power of the flame of a good torch and tip depend solely upon mixture and consumption of the gases in question. This obvious fact forces the necessity upon all those who handle torches, and wish to do conscientious work, *to measure the volume of the gases.*

The manufacturer is doubly interested in measurements of the rate of flow of the gases. Firstly: to produce an apparatus of minimum integral consumption and maximum effectiveness. Secondly: To test and check apparatus in the course of manufacture and when completed.

To those familiar with the considerations that have to be given, to sectional changes of gas conveying and mixing chamber ducts and orifices, know the importance of the factor alluded to. One weak link in the chain of these requirements must diminish the effectiveness of the torch.

The determination of the distribution and changes of the rate of flow, within and about the torch, will ultimately lead to a more perfect torch design; one more perfect in manipulation as well as in application. It will also clarify the disputes pertaining to the application of various pressures to different torches or tips.

Investigators will go a step further, they will soon be after accurate data pertaining to the change in consumption and mixture, due to the heating of the torch and tip while work is progressing. Also changes due to other causes will be traced, such as disturbances originating at or near the source of gas supply.

THE AUTOGENOUS WELDING OF RAILS.

There has already been published articles on the welding of railway rails and it is one of the big problems in railroad work. The present practice of bolting rails together has two disadvantages; first the joints permit a jarring of the equipment passing over them; which is the cause of a great deal of the fatigue noticeable in the metals used for railway coaches and locomotives and, second, there is the item of the passengers' comfort. There has been a constant effort made to provide a continuous or as nearly continuous rail as possible and Oxy-acetylene, Electric and Thermit welding have been suggested and tried in the past.

Professor C. F. Keel, Director of the Swiss Acetylene Society has published during the war a brochure on the subject giving the results of tests made on welded joints and describing a new method of making the welded joint.

There is given below an abstract of the article.

In Switzerland because of the many tunnels and bridges the matter of a continuous rail is important, because of the otherwise continuous shock given to the structure by joints. The railways have sought to minimize these shocks by making the rails as long as possible, some rails in use have a length of over 100 feet.

The process of rail welding proposed by Professor Keel is as follows:

The base of the rail is welded and the head but the upright section is cut out by means of the torch. It is proposed to use as well the ordinary fish plates as used at present to assist in maintaining the alignment of the rails. In the past considerable difficulty has been encountered in preserving the alignment of rails welded through the upright section but in the present process no such difficulty is encountered. In the case of rails already laid, the author recommends that base be welded first and then the head, but if practicable, it is far more advisable to turn the rail over and weld the base from the bottom side in order that the weld may be larger. The base section of course is subjected by the passage of trains to a greater strain than the head section and the weld must be made with the greatest care.

For a welding rod Prof. Keel proposes to use a metal as nearly like that of the rail as possible. Swedish steel has been used and tests have shown that weld is always softer than the metal of the rail. The welding rods used contained some silicon and some manganese. A flux with a base of sodium carbonate and sodium bicarbonate has been used. Hammering increases the hardness or denseness of the weld. The weld on the base section is hammered when the weld is finished and while still red, the head section is hammered first when the weld is one-half completed and after the completion.

On the subject of the cost of the work, the edges were beveled by the torch and the upright section was cut out by the torch which increased the costs of performing the work. 300 to 400 litres (10.5 to 14 cu. ft.) of oxygen and 150 to 200 litres (5.25 to 7 cu. ft.) of acetylene were used for cutting and beveling each joint If the work of welding was carried out in a shop the consumption of oxygen would be 1,200 litres (42 cu. ft.) and of acetylene 900 litres (31.5 cu. ft.); if carried out in the open air the consumption would be increased to 1,600 litres (56 cu. ft.) of oxygen and 1,200 litres (42 cu. ft.) of acetylene. One hour to one hour and one-half is required per joint made, one-third of the time is required for preparing the joint and two-thirds for the actual welding. The author suggests as a possibility of cutting down the cost the use of a preheating torch. Professor Keel also advocates the bonding of rails by welding, he makes use of an iron wire of appropriate diameter to each end of which is fixed a plug. This plug is inserted in a hole provided in the upright section of the rail and the bond is welded in place.—Revue de la Soudure Autogene (Paris).

A Corner of the Production Department of the Detroit Plant of L. Lawrence & Co. Cylinders from Far and Near. They Go Back Into Service As Good As New.

WELDING SCORED CYLINDERS *and* DEFECTIVE CASTINGS

IT is well known that a great many cylinders of internal combustion engines are damaged by wear and very often they are scored by foreign matter getting into the cylinder or by parts of the apparatus becoming disarranged and scratching or gouging the interior of the cylinder so that there is no tight fit between the piston and the cylinder, and thus causes poor compression and the engine soon becomes useless. The scoring is very often caused by reason of a wrist pin coming loose and being carried along by the piston and scraping the interior wall of the cylinder so that it becomes channeled or scored.

It has heretofore been the practice to repair scored cylinders by grinding or reboring them. This is a very slow method and is expensive because of the time required for the purpose, and such manner of repairing necessitates the use of a new size piston and ring. Also each time a cylinder is reground it is weakened and the wall of the bore is made thinner. Another method has been to weld the scored parts to the cylinder, but in subjecting the cylinder to a welding heat the same becomes warped, and, therefore, in the majority of instances requires regrinding or reboring, and a second disturbing of the contour of the inside of the cylinder wall.

L. Lawrence & Co., owners of the patents covering the process of repairing scored cylinders, main offices in the Woolworth Building, New York City, began business at Newark, N. J., in 1862, making copper work for manufacturing concerns.

This company also is the owner of patents covering the repair of sand holes and blow holes in rough castings, and are doing a very large volume of business for well known automobile concerns and foundries throughout the states.

The head of the firm invented the Lawrence Patented Process for repairing scored cylinders in 1915 and the business grew so fast that it was necessary to open a branch plant at Detroit, Mich., in May, 1916. Right after the Lawrence company exhibited at the 1916 automobile show at the Coliseum, Chicago, a branch was established in that city.

A branch plant was opened at Cleveland in 1917. On the Pacific Coast the demand for the Lawrence service has required the concern to establish plants at both San Francisco and Los Angeles.

The Chicago plant has been getting so much work from the Wisconsin, Minnesota and northern Michigan territory that

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WELDING RODS

Welding Submarine Cable with Oxy-Acetylene and ARMCO IRON Welding Rods.

Repairing a Tank with the Electric Arc and ARMCO IRON Welding Rods.

ARMCO IRON is the STANDARD guaranteed welding material

Why experiment with inferior products which endanger the weld and cause loss of time and money?

STEEL AND WIRE PAGE QUALITY PRODUCTS

The cost of welding material is insignificant when successful welding, labor, and other items are considered.

ARMCO IRON Welding Rods may cost a trifle more per pound than some other welding rods, *but they cost less per average weld.* There is no waste due to lack of uniformity and no loss of time by the welder. They flow freely and make an even weld which lends itself well to finishing operations.

99.84 per cent Pure Iron Content (minimum) Guaranteed. In uniformity of composition and practical freedom from such foreign matter as sulphur, phosphorus, manganese, silicon, slag, and oxides, ARMCO (American Ingot) IRON actually surpasses the imported welding materials which conscientious welders once considered essential for the best results.

Two kinds of rods of guaranteed ARMCO IRON analysis, one for electric welding and one for oxy-acetylene welding, do all the work (and *better* work) that formerly was thought to require a wide range of welding rods of various analyses.

There are ARMCO Distributors in all principal industrial centers. Our nearest sales office will furnish you the addresses of distributors in your locality.

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The trade mark ARMCO carries the assurance that iron bearing that mark is manufactured by the American Rolling Mill Company with the skill, intelligence and fidelity associated with its products, and hence can be depended upon to possess in the highest degree the merit claimed for it.

Makers of ARMCO Iron Welding Rods and Electrical Wire; "Copperweld" Copper Clad Steel Wire; Wire Mill Products, Plain and Galvanized; Wire of Special Analysis; Wire Fencing for all Purposes; Factory Gates; Ornamental Iron Fence; Machine Guards; Tool and Stock Room Partitions; Architectural Iron.

Plants: Monessen, Pa., and Adrian, Mich.

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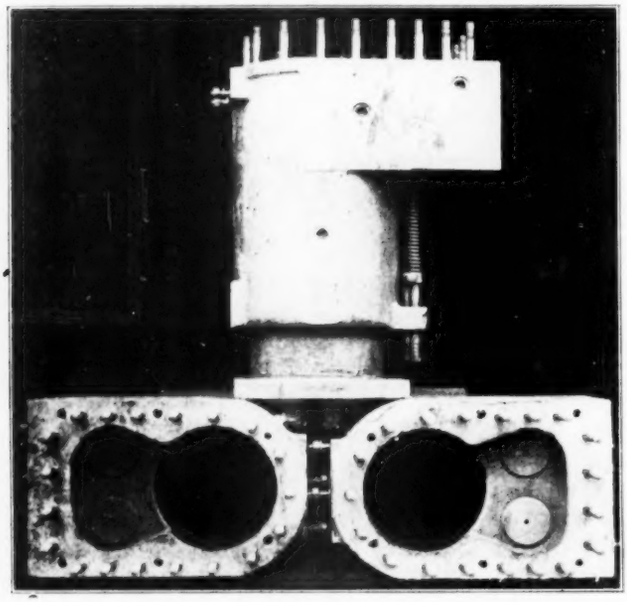
CHICAGO: 29 South LaSalle Street **DETROIT: Book Building**

SAN FRANCISCO: American Rolling Mill Company of California

CANADIAN DISTRIBUTORS: Taylor & Arnold, Ltd., Montreal, Toronto, Winnipeg

plants have recently been opened at Milwaukee and Minneapolis. This was done to avoid the shipping delays getting cylinders in and out of Chicago. Every winter the Chicago



Steam Cylinder Repaired by Lawrence Patent Process.

plant has repaired a great many cracked water jackets and scored cylinders for dealers in Wisconsin, Minnesota and northern Michigan, and the Milwaukee and Minnesota plants will shorten the time required for repairing.

Suits brought by the company against infringers of their patents have been won in several states. The firm makes special prices to automotive dealers who send scored cylinders in to be repaired and this policy has been largely responsible for the rapid growth of the business.

The greatest care is taken to finish all work so carefully that there are no "come backs" on the firm's policy of guaranteeing all work for the life of the motor. New mechanics who are learning the process are never permitted to finish a job alone until they have had sufficient experience and practice. The Lawrence officials realize that money spent in thoroughly training the mechanics saves both trouble and time later on.

The Lawrence company, outside of their twelve branch plants, are represented by representative and responsible people in seventy-six cities throughout the states, and bfore this year is over, with the aggressive campaign which is now in process, will be represented in every city and town of any size throughout the country. At least this is the aim of the organization.

L. Lawrence & Co. have grown to such an extent in Detroit, Mich., that it has been found necessary to secure other quarters and within six weeks they will have in operation the largest welding shop in the United States. The building which they are taking over is thoroughly equipped with the latest improvements in construction.

It might interest our readers to know that the Lawrence organization is to build up a national organization for the sale of automotive accessories, and with their branches and representatives throughout the country are in an excellent position to carry on this business in conjunction with their other work.

REMOVING BROKEN TAPS.

A tap, broken off in a hole, is often very troublesome to remove, and sometimes it costs less to throw away the part than to remove the broken piece with ordinary means. But the oxy-acetylene torch makes the job easy. The flame, directed against the end of the tap, will heat it so quickly that, generally, the sudden expansion will push back the walls of the tapped hole sufficiently to loosen it when slowly cooled off. If heating alone in this manner does not prove effective it will at least have so softened the hard steel that it can be drilled out. This is one only of the many profitable uses that can be made of oxy-acetylene apparatus in metal-working shops no matter what the line may be.

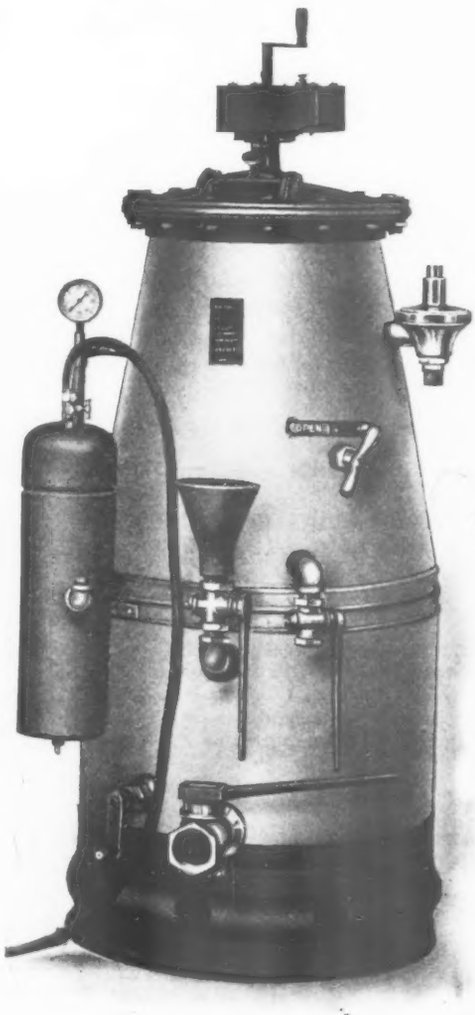
Two of the Substantial Plants of the L. Lawrence Co. Branches Such As These Are Located At Convenient Points Throughout the United States. The Plant at the Left Is Located at Detroit, the One At the Right in Pittsburgh.

This Equipment Cuts Welding Costs

Smith's Welding Torch and Smith's Automatic Acetylene Generator in your plant give you the two essentials of perfect welding at lowest cost. Install this apparatus and you do away with the trouble and delay of acetylene in drums, save gas, time and labor and do better work.

Smith's Welding Torch No. 4

For steady, accurate welding this torch is absolutely unequalled by any other torch on the market. It gives a soft flame that will not blow the metal. Won't flash back. Operates perfectly on low oxygen pressure. Has perfect balance and a comfortable grip that prevents fatigue. Made in three sizes and with nine brass tips. No. 404 cutting tip, attached in a few seconds, will cut up to 3 inches. Quickly pays its cost in time and labor saved. Lowest priced high grade torch made.



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Don't take the chance of depending on acetylene in drums. You can avoid costly delays and be sure of an ever abundant supply of pure acetylene gas by installing Smith's Automatic Generator.

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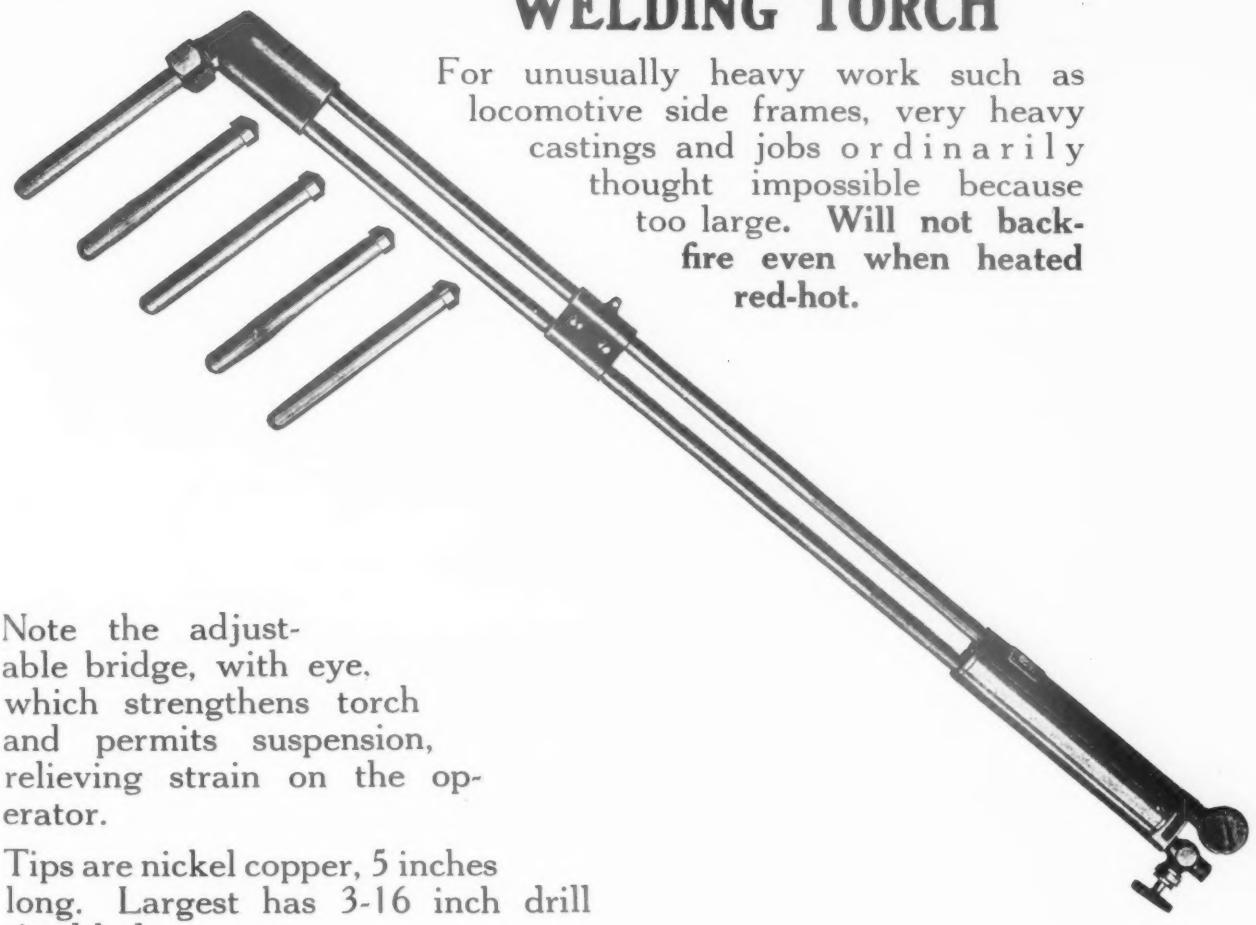

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FUSION WELDING APPLIED *to* DROP FORGINGS*

Oxy-Acetylene and Electric Welds and their Applicability to Defective Forgings—Effect of High Temperatures on Physical Structure

By S. W. Miller

IN connection with the application of fusion welding processes to drop forging a number of questions have to be considered before a decision can be made as to their use. The principal ones are as follows: First, can any fusion process be applied; second, if so, what process should be selected; third, will a forging reclaimed by welding be satisfactory to the customer; fourth, will a welded forging give as good results as one not requiring welding; fifth, will the cost of welding be greater than that of a new forging? It would appear clear that the answers to some of these questions are not within my province, as I cannot decide for instance, whether a welded piece, no matter how good the job was, would satisfy the customer, nor can I decide as to the relative costs of welding pieces and new forgings. What I propose to do, therefore, is to merely present my ideas as to the possibilities of producing certain results by welding. I am not concerned with the third and fifth questions.

There are two methods of fusion welding which are applicable to the repair of drop forgings. Each one has its peculiarities, limitations, and advantages. They are the oxy-acetylene and the metallic electrode are (electric). The melting temperature is maintained in the former case by the combustion of acetylene in the presence of oxygen, which gives the highest flame temperature known, about 5000 deg. Fahr. In the second method, the melting temperature is obtained by using the electric arc drawn between a metal electrode and the piece to be welded. The temperature of the arc so formed is higher than that of the oxy-acetylene flame.

I believe it will be generally found that the oxy-acetylene process is more applicable to the reclaiming of drop forgings than the electric, especially where the defects are small; because, while the electric process is considerably cheaper (the cost of operation being only about half that of the oxy-acetylene), yet there is greater liability with the electric process.

Characteristics of the Two Methods

In order to make clear the effects of welding, it should be considered that the heat of the welding flame or arc is very high and that there is a strong tendency to burn out, both from the welded piece and the weld itself, such elements as carbon, manganese and silicon, so that the weld is usually of very different composition chemically from both the original material and the welding rod. A material commonly used for oxy-acetylene welding is steel wire containing about 0.10 per cent carbon, 0.15 per cent manganese, and phosphorus and sulphur less than 0.04 per cent. These may be considered the usual maximum figures, although there is considerable variation in different welding wires. For special purposes, other wires may be used and some of these will be considered later. With the above wire, the carbon will be reduced in the weld to about 0.05 per cent, the manganese to about the same amount, while the sulphur and phosphorus will remain about as they were, so that such a weld is a quite pure iron casting. If properly made, the weld material will have an ultimate strength of about 52,000 lb., a yield point of about 25,000 lb., and an elongation of about 20 per cent.

The chemical composition of wires used for metallic electrode work, (electric welding), varies widely. One of the best contains about 0.15 per cent carbon, about 0.50 per cent manganese, and sulphur and phosphorus not over 0.04 per cent each. In passing through the arc in the form of a vapor, as it does, there is naturally a great opportunity for the metal to lose its carbon and manganese and to become oxidized. Such metal in the weld will contain about 0.03 per cent carbon and about 0.2 per cent manganese, the sulphur and phosphorus being practically unchanged. Its tensile strength will be about 55,000 lb. per sq. in., the yield point nearly equal to the tensile strength, and the elongation about 3 per cent.

The effect of the heat on the material being welded is different also in the two processes. With the ox-acetylene method, the temperature is not so high nor is it so local, the result being that the heat effect extends a greater distance from the weld, and, as the heat has to be applied longer, the coarsening of the grain near the weld is greater than with the electric method.

The quality of the material being welded should also be considered. If it is a plain carbon steel, the higher the carbon content, the greater the injury by welding to its physical characteristics. The writer's experience leads him to believe that material up to about 0.5 per cent carbon can be satisfactorily welded, provided it is properly heat treated to remove the grain coarsening. By this he means that there is no permanent damage to the material. He does not mean necessarily that the welded piece will be satisfactory, even if the weld be sound. This is a matter that will be considered later.

Considerations Before Welding

It is, therefore, evident that three things have to be considered in deciding as to the quality of a welded piece: First, the effect on the piece itself; second, whether the weld will be sufficiently strong and otherwise suitable, and third, whether heat treatment can be applied to improve the qualities of the welded piece and the weld. The answers to these questions evidently depend on the results desired.

If heat treatment is to be applied, some consideration should be given to the effect of this heat treatment on the welded piece and the weld. In an examination of the effect of such treatment on oxy-acetylene welds made in material containing about 0.18 per cent carbon, the writer found that there was a difference of about 300 deg. Fahr. between the refining temperatures of the material and the weld, the latter being made with wire of the composition above referred to. This is accounted for by the difference in carbon content, and also by the fact that the weld is a casting, which requires a higher refining temperature than a forging of the same carbon content, in order to obtain the best results. Therefore, when welding material of this kind is used, a double heat treatment is necessary, a high temperature, about 1700 deg. Fahr. for refining the weld, and a lower one, about 1450 deg. Fahr. for refining the original material. It would seem advisable from

*A paper presented before the sixth annual convention of the American Drop Forge Association, Pittsburgh, June 14. The author is proprietor of the Rochester Welding Works, Rochester, N. Y.

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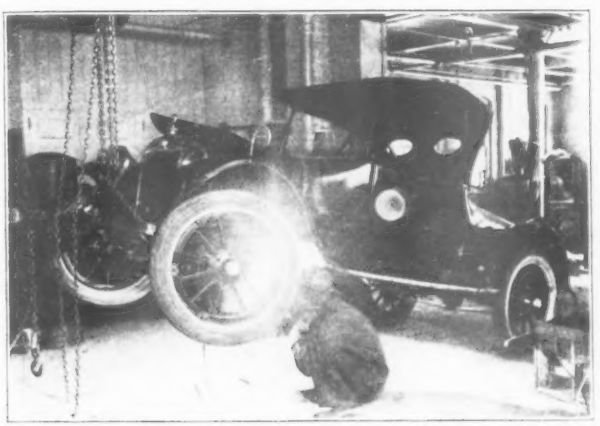

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this to provide a welding material, which in the weld will require the same refining temperature, and which would have the same physical characteristics as nearly as possible, as the material being welded. Whether this is possible or not is a question which has never been decided to the writer's knowledge. It would depend largely on the nature of the original material. It would appear possible to increase the carbon in the welding wire so that in the weld there will be the same carbon content as in the piece, but another difficulty is introduced, which is a practical one. Such welding material is difficult to handle and unless extreme care is used, the weld will be full of laps and oxide films, and it will be more dangerous than one made with low carbon material. Of course, careless welding with any material will make laps, etc., in the weld. Another solution may lie in the direction of using alloy steels, such as vanadium. These make welds free from oxide, and in which the carbon is largely preserved, but they are, unless annealed, exceedingly brittle. As a matter of fact, there has never been sufficient demand for such materials to warrant any research in connection with them, but the writer feels that the time is at hand when this and similar investigations will have to be carried out.

As illustrating the effect of heat treatment, part of a weld was heated to 1550 deg. Fahr. quenched in oil, drawn at 800 deg. Fahr. and cooled in air. * * * The weld of course contains less carbon than the material welded, so that more ferrite is shown in the weld, but it is easily conceivable that for certain purposes such a weld would be entirely satisfactory. This is an illustration of the line of investigation that must be followed in order to determine whether welding in any particular case may be permitted. Of course, physical and chemical tests would also have to be made.

Effects of Heat Treatment

It has been found that heat treatment such as outlined above increases the ductility of sound oxy-acetylene welds made with ordinary materials. Of course, it cannot improve defective welds. More work will be required to determine the amount of improvement, and in what directions it takes place. not getting thorough fusion at the beginning of the work. In other words, as the arc is drawn between a rather heavy mass and the electrode, the former requiring some time to be brought to the fusion point, the beginning of the weld is liable to be imperfect, while with the oxy-acetylene method the piece can be brought to the melting point before any metal is added, thus insuring thorough fusion. These points then should be considered in deciding which process should be used. There remains for discussion, therefore, only the fourth question, which refers to the quality of the weld itself and the effect of welding on forging. The more important of these is the quality of the weld.

To begin with, it should be understood that the writer is not advocating, and has never advocated, the indiscriminate use of welding processes. His belief is that for many purposes a welded piece is just as good as one that does not need welding, but he also believes that there are many cases where a welded piece will not give satisfactory results, and in those cases he advocates very strongly that the pieces be scrapped. The reason for this lies in the nature of welds. A fusion weld is a casting, and no matter by what process it is made, and no matter how good it is, and no matter to what heat treatment it is subjected, it cannot have all the qualities of a forging, so that where a heat-treated casting will not give good and safe results, a welding process should not be used.

It is known that nickel increases the tensile strength of oxy-acetylene welds, but at the expense of ductility. Welds made with such material are also liable to contain numerous gas pockets, probably due to the nickel present.

With regard to electric welds, the writer has not yet found it possible to improve their elongation by any method of heat treatment. The large amount of nitride of iron present in such welds does not seem to affect their strength, because they rupture along the grain boundaries, even when there is no appearance there of any oxide or nitride films under the highest power of the microscope. The writer believes that such intergranular brittleness is due to ultra-microscopic films of oxide of iron, and is not aware of any way of eliminating these at the present time. * * * It also does not seem to make any difference what material is used for electrodes. This problem will undoubtedly be solved, but it will take time and patient investigation.

Electric welds are also subject to defects, but clean electrodes and careful welding help to eliminate them.

Less Successful With Alloy Steels

With regard to the welding of alloy steels, the writer has very little information. In his shop, he has not found good results in the few cases in which he has used it. It is evidently foolish to expect that a chrome nickel steel heat-treated forging can be satisfactorily welded, even with the same material as that of which the forging is made, and owing to the sensitiveness of alloy steels to heat treatment, he is at present very dubious of the results.

The question of cost enters into all this work to a very large extent. It might pay to repair drop forged automobile axles by any welding process because of the expense of the forging, while it certainly would not usually pay to repair a small lever. Also the results in the case of the axle would be entirely satisfactory, where, for example, a corner of one of the spring pads did not fill out in the die, because there is a surplus of strength at that point, and in the writer's shop similar repairs have been frequently made by both processes. Axles broken in the middle by collisions have been welded and many other repairs have been made which are considered perfectly safe and which have never given any trouble in service.

There is one thing which the writer would strongly urge, which is that those responsible for the welding make sound welds. It is rather remarkable how few welders, according to the writer's experience, are capable of doing this, and he has found that even welders who are supposed to know how to do good work, have never been trained to make reliable and uniform welds. As illustrating this, the writer knows of one test in which two welders of more than ordinary ability and experience welded five test pieces each. The average tensile strength of these ten pieces was somewhat over 46,000 lb. (not per sq. in.) An examination of the fractures showed lack of proper fusion and other imperfections which accounted for the low strength. Another welder who had been specially trained then made a test piece, with the same welding material, which broke at 56,000 lb., the weld being free from imperfection. To show what can be accomplished, the writer has a record of 15 welds made in ½ x 3½-in. material, the test pieces being machined all over, which gave the following results:

	T. S.	Y. P.	Elongation in center in. Per cent	Elongation in 5 in. Per cent
Maximum	52,300	37,100	28	26
Minimum	50,600	32,100	17	10.6
Average	51,900	33,180	23	15.6

As showing what can be done with somewhat better welding material, the following are the averages of three pieces made under the same conditions as before:

	T. S.	Y. P.	Elongation in center in. Per cent	Elongation in 5 in. Per cent
Average	53,100	37,600	31.1	20.7

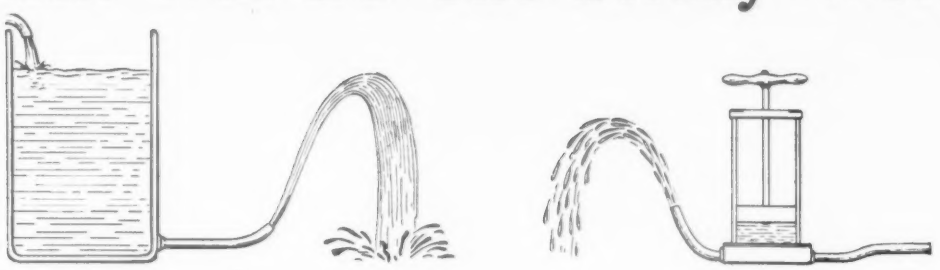
Foreign Matter Impairs Results

In making electric welds, the conditions are such that it is difficult to get them free from films of oxide, slag pockets, etc.

(Continued on Page 54)

LINCOLN ARC WELDER

Which Will Do The Steady Work?



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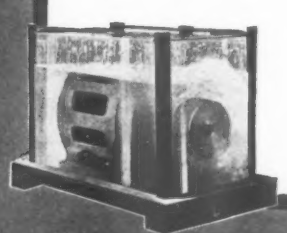

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What has become of the old fashioned fellow who said the end of the war would see a slump in the welding business?

What has become of the O. F. F. who usually writes us about this time of year and tells us how he welded a ten-ton fly wheel (all broken to pieces) without preheating?

What has become of the O. F. F. who wants us to tell him in strict confidence the very best torch on the market?

What has become of the O. F. F. who admitted that he had only been welding seven years? It's usually nine years at least.

What has become of the O. F. F. who wrote us for directions for making a good home made generator? We told him to take it out in the middle of a big field and try it out and we haven't heard from him since.

Ho hum! This is a funny month—not a kick yet.

Trade Unionism.

SOME of our readers may not be aware of the fact that there are a number of organizations of welders in many of our larger cities and manufacturing districts. Is is a fact, however, that not less than ten or fifteen associations of welders and cutters have been organized this year, the most of them in shipyards. As yet these organizations have no central body and the plans they are making have no relation to each other. It is only a matter of time, however, until a National organization will come, and when it does come we hope it may be a safe and sane organization and one which will have for its chief concern the welfare and development of the welding industry.

We do not believe the welders themselves would profit so much by a strong labor union as they would by an organization the chief purpose of which would be to educate welders, increase their productive ability and at the same time educate the public to the practicability, efficiency and economy of autogenous welding. A good all around welder, one who is competent to weld any weldable metal, a welder who has had the necessary mechanical training and experience, can command a rate of pay which compares favorably with other trades. There are more vacancies for such welders than there are welders to fill the positions. Therefore it would seem that the future of the welder, and this means the manufacturing side of the welding industry as well, lies in our ability to provide more knowledge and information about the science of welding.

The chief reason why welders throughout the country seem to desire a National organization seems to be because of the attitude of other trade unions toward welders. They are being told that welding is not a trade and it is necessary for them to hold cards in some one of the other unions in order to do work which is claimed by that particular union. The older unions are not as a rule very friendly to welding. They fancy they can see too much work slipping away from them, and for this reason there is a tendency to put every obstacle in the way of the progress of the craft. This of course is as harmful to the welfare and prosperity of the manufacturer as it is to the welders.

From this point of view it would appear that there are things which a National association of welders could accomplish. However, we offer the opinion that trade unionism in the United States has passed the peak of prosperity and is on the down grade. Time was when capital exploited labor to the extent that the worm turned. We have now reached the point where the situation is exactly reversed and Red Radicals are using labor unions in an attempt to make a second Russia out of the United States. In Gary, as an example, the ignorant non-English speaking labor has been made to believe that it is possible for them to own the mills. Ninety per cent of the American born employes are working, and as a matter of fact they constitute the real bulk of the *skilled* workers.

There are more than one hundred million people in the United States and not more than one-third of them are members of any labor union. They are the citizens who really have a right to want to start something and it has come to the point where we believe the poor outsider, over sixty million of him, is mighty sick of hearing the word "Strike." So instead of trying to start a union we believe the welders of the United States could accomplish more by either founding a National Educational Association or Society or by inducing some existing association to make room for them in their body.

A New Street in Our Town.

STREETS are avenues of communication. By means of them people are able to travel to their destination. In olden days folks depended upon cross-lot trails—the means of communication being both tortuous and uncertain.

The welding field, so far as the transmission of information was concerned, used to be in something like the same position as the frontier settlement—dependent upon "cross-lot avenues" of communication. That was before *The Welding Engineer* was born.

Welding has come to be a most important branch of mechanics. By means of welding by one of the several processes whole industries have been revolutionized. The growth of the welding industry during the last few years should not be attributed to a wave of prosperity which has swept over this country, but rather to the fact that welding by *some* process is an efficient and economic practice.

We may confidently expect the field to expand, and certainly a powerful aid in the enlightenment and expansion of any industry is a strong, fearless, well-constructed trade paper.

When *The Welding Engineer* was first established we announced our policy and gave nine reasons why we would be

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successful. Our code of ethics was as follows and we believe we have lived up to them:

1. To consider first the factor of safety. *The Welding Engineer* is unalterably opposed to the manufacture or sale of unsafe devices.

2. To consider and safeguard the interests of the subscriber.

3. To keep reading columns independent of advertising considerations and to measure all news by this standard: "Is it real news?"

4. To decline any advertisement which has a tendency to mislead or which does not conform to business integrity.

5. To solicit subscriptions and advertising solely upon the merits of the publication.

6. To supply advertisers with complete and reliable information regarding quality and character of circulation, including detailed circulation statements, subject to proper and authentic verification.

7. To co-operate with all individuals and organizations in stimulating and extending the welding business.

8. To avoid unfair competition.

9. To determine what is the highest and largest function of the field and then to strive in every legitimate way to promote that function.

Fixing the Responsibility.

WELDERS are often willing, even anxious, to credit their apparatus with their failures, when as a matter of fact, failure almost always follows in the wake of inexperience. Sound welds depend not only upon the apparatus, but also upon the intelligence and ability of the operator.

We make the broad statement, and we believe we underestimate the figures, that fully one-third of our so-called welders are not welders at all—but more truly **plasterers. Some** of them make good welds, **some** of the time. Just why they make good welds some of the time, we are sure we don't know and we know they don't know.

This type of welder, unwilling to learn, indifferent to his own progress, concerned only with the prospect of being paid more than he is worth, is the one barnacle we must deal with in the welding trade.

After several years' experience in welding, how many welders conduct little experiments and tests on their own account? After reading what some old timer, or some young welder with a new idea, has to say on a welding subject, how many of you welders give the matter a second thought?

The progress which has been made in the oxy-acetylene field at least has not been made by college men. It has been made by self-made welders. Often they have not been able to determine just why they were successful, a gap which we are glad to say, is being gradually bridged by scientific men; but we feel that the future development of welding demands the more earnest concentration of the rank and file.

We are laboring in a fertile field—a field which offers more promising opportunities for a hustler and a go-getter than most fields. If we are satisfied to stand still—take that which comes our way—then our industry, the art of autogenous welding, will suffer.

Progress

WE remarked once upon a time that we had made more progress recently in welding on this side of the water than our friends in England and France. This may be true so far as apparatus is concerned but we do not think we have done as much to educate the public as England has done, and is doing, and for that matter we certainly are not doing as much to educate the welders. For the welder England has a whole flock of schools, and because of the great difference in the size of the two countries they are very centrally located. It would also seem that the British Acetylene and Welding Association loses no opportunity to demonstrate to the public the utility of autogenous welding. The September issue of our British contemporary, for instance, states that by invitation of the Committee of the Shipping, Engineering and Machinery Exhibition, the oxy-acetylene process is strongly in evidence at the exhibition, welding under water being demonstrated by one firm.

BOILER WELDING

In commenting on an article on boiler welding published in *The Welding Engineer* recently our British contemporary says: "Oxy-acetylene welding and cutting has, in recent years, revolutionized a great many industrial processes and as regards practical results, ranks as a marvelous achievement in the field of industry. No other process of repair has such a vast number of applications, and in the elimination of waste and as a saver of time and expense in all branches of industry the process stands by itself. Starting as an obscure process, subjected to opposition and criticism, and generally the object of unskilled and careless manipulation, it has in a comparatively brief period of time taken its place as an indispensable resource of industry. One of its most interesting applications is the repair of boilers.

"Remarkable work has been carried out in recent years, principally in America, on marine, locomotive, and portable boilers. Cracks, patches, and entire sheets are now welded with complete success. Repairs on this class of work, however, require, on the part of those carrying them out, wide experience, great care and careful study; and, as it should be, they are generally carried out by firms specializing in this class of work.

"Investigation shows that a well-known French engineering firm was applying the oxy-acetylene process for the repair of boilers more than fifteen years ago, and that in England, Italy, France and Spain workshops carrying out marine repairs and making use of the process have been established at the principal ports for a long time.

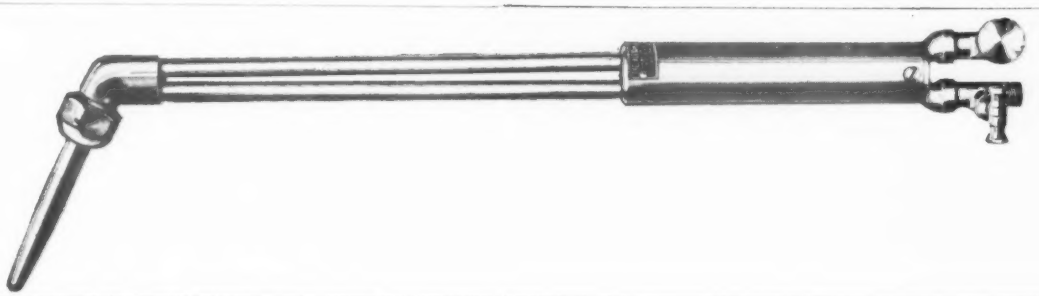
"It is only in the last few years that America has applied the oxy-acetylene process to the repair of boilers but they have rapidly made up for lost time, and, especially since the end of the war, they have made great progress in this class of work.

"Does it follow that having been out-classed by the daring and remarkable type of boiler repairs they have carried out we are to blindly follow their methods?"

AT THE D-B INSTITUTE

Remarkable results have been achieved in a few weeks by intensified trade training. Bright young men have been taught to run an engine lathe on repetition work and produce more work that would pass inspection than some old machinists could turn out in the same time. Likewise they have been taught to operate other machine tools and become competent to handle a variety of machine work with a few months' experience. But young men lack that experience in general which would enable them to enter a new shop and produce in unfamiliar surroundings and on strange machines the quality of work that could be turned out by the older man. The welder trained in a trade school learns in two or three weeks the principles of efficient welding and cutting. But that does not make him an experienced welder. He must go forth and work in strange surroundings and produce results under conditions far from ideal. No school training can take the place of practical experience, but school training can fit a man to more quickly absorb and profit by experience than the untrained man.

The Milburn Quick-Weld Torch is Different Because It Welds on Equal Pressures



BY using equal pressures of Oxygen and Acetylene all danger of oxydizing the metal is eliminated and the consumption of oxygen is greatly reduced. Oxygen is the expensive part of any welding job. Cutting your oxygen consumption means cutting your greatest expense. The efficiency of the Quick-Weld is not sacrificed by operating on equal pressures. In fact it is the most efficient as well as the most economical torch on the market.

This torch is proving its value to hundreds of firms all over the country. Try one at our expense. Write for Booklet No. 34 which describes it in detail.

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Milburn welding and cutting torches are covered by U. S. patents and the Alexander Milburn Company guarantees full protection to vendors and users of its products.

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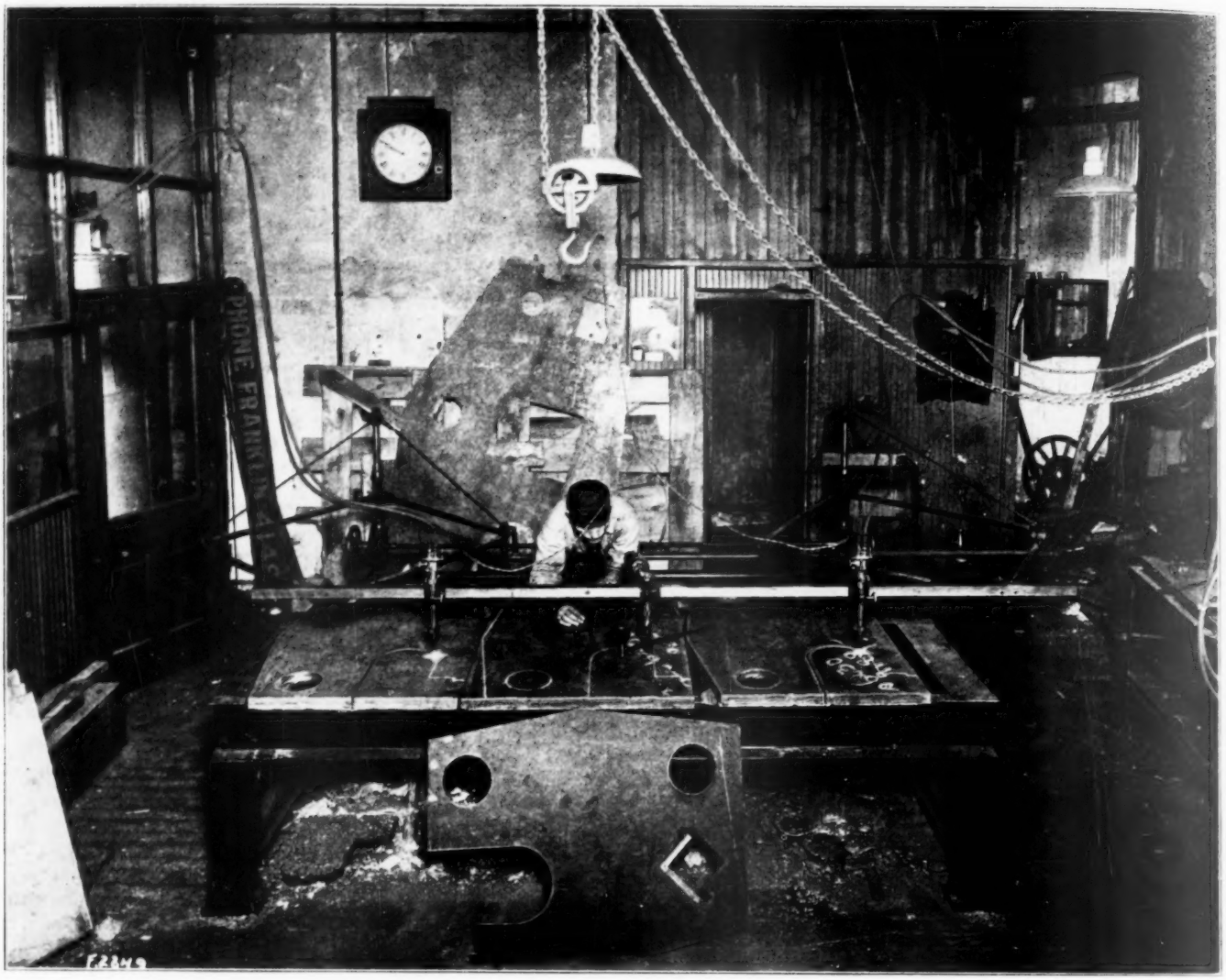

Fig. 8. One operator using No. 2 Oxygraph to cut two plates at the same time, which increases production and lowers costs.

CUTTING 720 LINEAL FEET OF ½-INCH STEEL PLATE AN HOUR WITH ONE TORCH

By Fred J. Maeurer*

SINCE the armistice was signed in November, 1918, assuring cessation of hostilities, the writer has read with considerable interest the numerous articles that have appeared in the various trade papers showing Oxy-Acetylene Welding had done its bit towards winning the war, but little or nothing has been written showing what Oxy-Acetylene Machine Cutting had done to gain this same end. It was my good fortune to visit practically every large shipyard and steel mill in the Central West during the war, and I will endeavor to show and explain the various machine operations that could not under any circumstances be done as quickly or economically as these various machines did. Cutting was done with these same machines that was so fast, smooth and clean that no machining, chipping, or grinding was required after cut was completed.

The increasing cost of labor and materials has now reached the point where mills, shipyards and large and small manufacturing plants have a real problem on their hands, as the cost of some of their operations are entirely out of reason with their former costs, and this condition is forcing production managers and engineers to give a great deal of attention to Machine Cutting and Welding as a means to speed up production, at the same time cutting down their labor costs. That these machines are capable of doing this is illustrated by the accompanying illustrations. Contrary to some articles I have read, the development of ma-

*Superintendent Chicago Shops, Davis-Bournonville Co.

chine equipment is not a product of the war, as this development has been going steadily forward as far back as 1910, to my personal knowledge, and when we were plunged into the World's War Machine equipment had already been in use several years. War did not bring out or develop Machine equipment, but it certainly did force the adoption of Machine Cutting to a large variety of work that had not been previously attempted, that could best be done with Machine equipment. The operations I mention and show are only those that I have personally seen, and that there were thousands of other operations performed all over the country cannot be questioned.

Due to Government restrictions, no photographs were

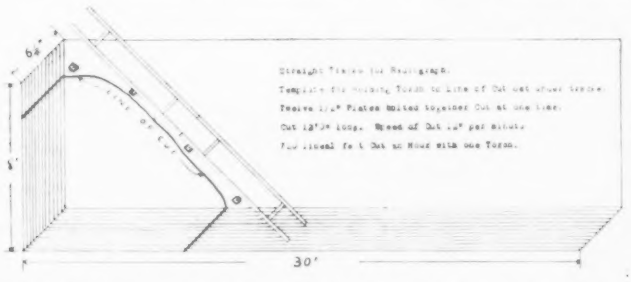

Fig. 1. Straight tracks for Radiograph. Template for holding torch to line of cut is set under tracks.

allowed to be taken during the war period, so it will be necessary to show line drawings to illustrate some of these operations.

In one of the largest mills in the Central West engineers were confronted with a proposition that called for a cut to be made on ½-in. steel plates. These plates were approximately 8-ft. wide by 30-ft. long, as per Fig. No. 1. This cut was 12-ft. in length of sixteen different radii, that after cutting were to accurately fit other pieces or forms. Hand cutting was figured on, and it was found that too much chipping and grinding was necessary in addition; also to continue hand cutting involved the purchase of at least ten new hand cutting equipments. The engineers then turned their attention to Machine Cutting and purchased a No. 1A Radiagraph. A template was then made exactly like the cut to be made, with the various radii, out of ⅛ in. black iron 15 in. wide. A special torch was then built, which

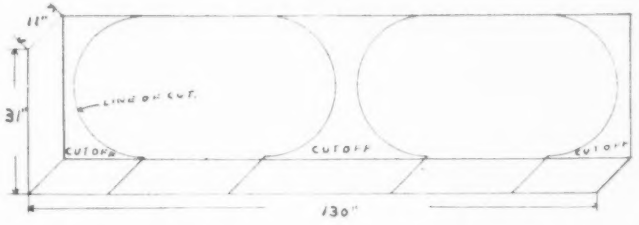

Fig. 2. Large steel slabs (30 in. x 11 in.). Cut by No. 1A Radiograph.

swung freely on the post of the machine, and a spring attached to post and torch to keep torch against template, so that while the Radiagraph would run on a straight track the spring would hold the torch to the template, making this cut exactly as laid out on blue prints.

In cutting one plate at a time, the set speed was 22 in. per minute and it was found that this was too slow, as these plates were to be delivered at a certain time that was fast drawing near. Four plates were then stacked up and cut at one time. Eight plates were next stacked up, one on top of another, and cut at one time. These two cuts were so successfully made that it was decided to cut twelve plates simultaneously. After these plates were set up a bolt was set every three feet to hold plates as close together as possible. The speed of the Radiagraph was set at 12 in. per minute, thus the cutting speed on the single ½-in. plate was 144 in. per minute or 720 ft. per hour. The cut was so successfully made as to speed, smoothness, straight vertically, and so clean and to the line, that they were ready to be installed without any further labor. The balance of these plates were cut as described. To the writer's knowl-

Fig. 4. Flanges for Government Gun Cotton Converters. At left the machine is completing a cut on flange.

edge, this is the first time so many feet of half inch plate have been cut by a single cutting torch in one hour.

At this same plant, large steel slabs 31 in. and 11 in. thick were being cut by Oxy-Acetylene, as shown in Fig. No. 2. This operation consisted of rounding off both ends and was being done with a hand operated machine, the torch moving up and down by a worm screw and moved in and out to conform to radius on a bracket; one man operated a

Fig. 3. Stock cut into round sections for drop forgings.

hand wheel on a screw to move torch forward; one man operated hand wheel on a bracket to move torch in or out, while a third man held and moved hose in and out as the torch moved. The length of this cut was 44 in., and time consumed in making this cut by hand operated machine was 21 minutes. This cutting was a great deal more economical than free hand cutting, and smoother, but they found it did

not eliminate the machine work that was necessary after cutting.

This operation required the services of three men to make a cut. The writer questioned the necessity of a man to hold the hose, and it was explained that this was necessary, as it was impossible for the second man to move torch in or out when the hose was lying down, as the weight of the hose would bind torch on bracket. The Radiagraph was then used on this cutting, and not only did the cutting in 11½ minutes, but cut the gas consumption in half, requiring the services of but one man. The cut was so much smoother that machine work was cut down to the minimum.

It will be noted from the above that this cutting was carried on at the rate of close to four inches per minute.

Fig. No. 3 shows stock cut into round sections for drop forgings, which were 9 in. thick and 31 in. in diameter. The time for this cut was 20 minutes and will illustrate fully the smoothness of Machine Cutting on heavy stock such as mentioned above.

At our own plant, large Gun Cotton Converters were being welded for the United States Government, and part of these converters consisted of a flue sheet 2½ in. thick by 45 in. in diameter and heavy flanges also 2½ in. thick by 45 in. in diameter. These plates came to us in 46-in. squares.

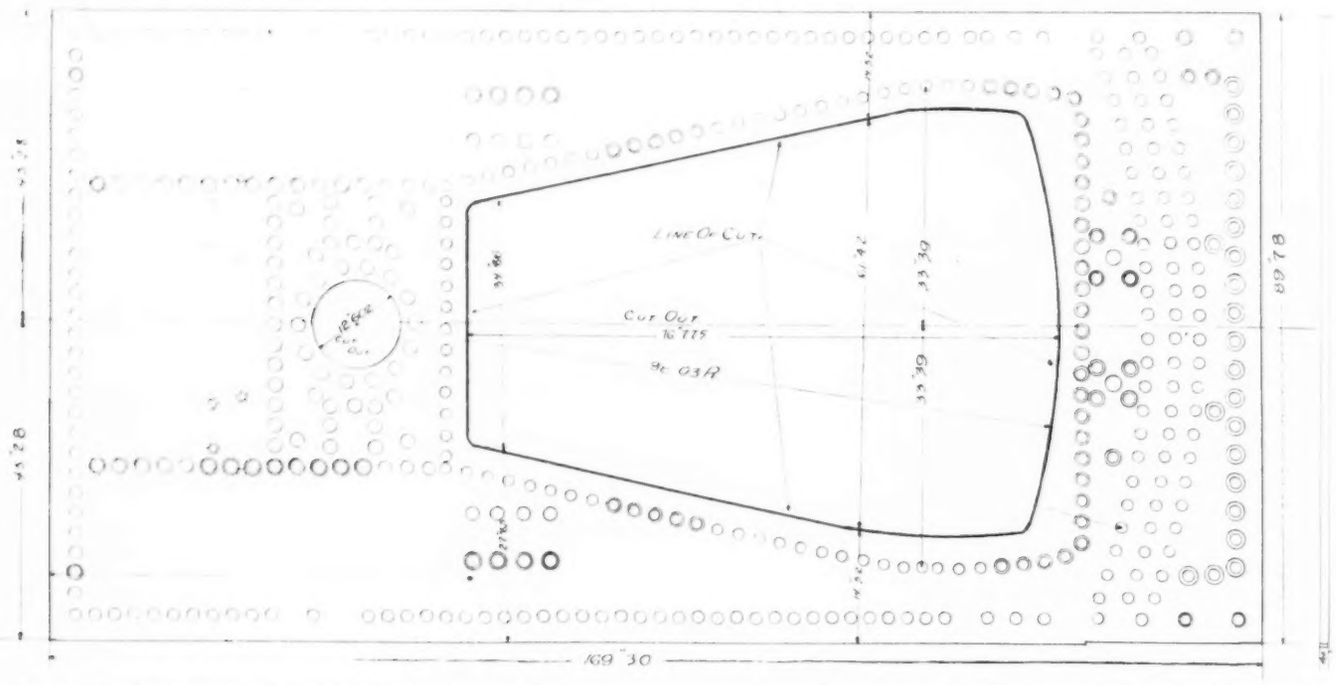

Fig. 5. Top plate for big gun carriage. Attention is directed to the accuracy required in these cuts. This is a splendid illustration of how close machine cutting can be done when the machine is properly rigged up.

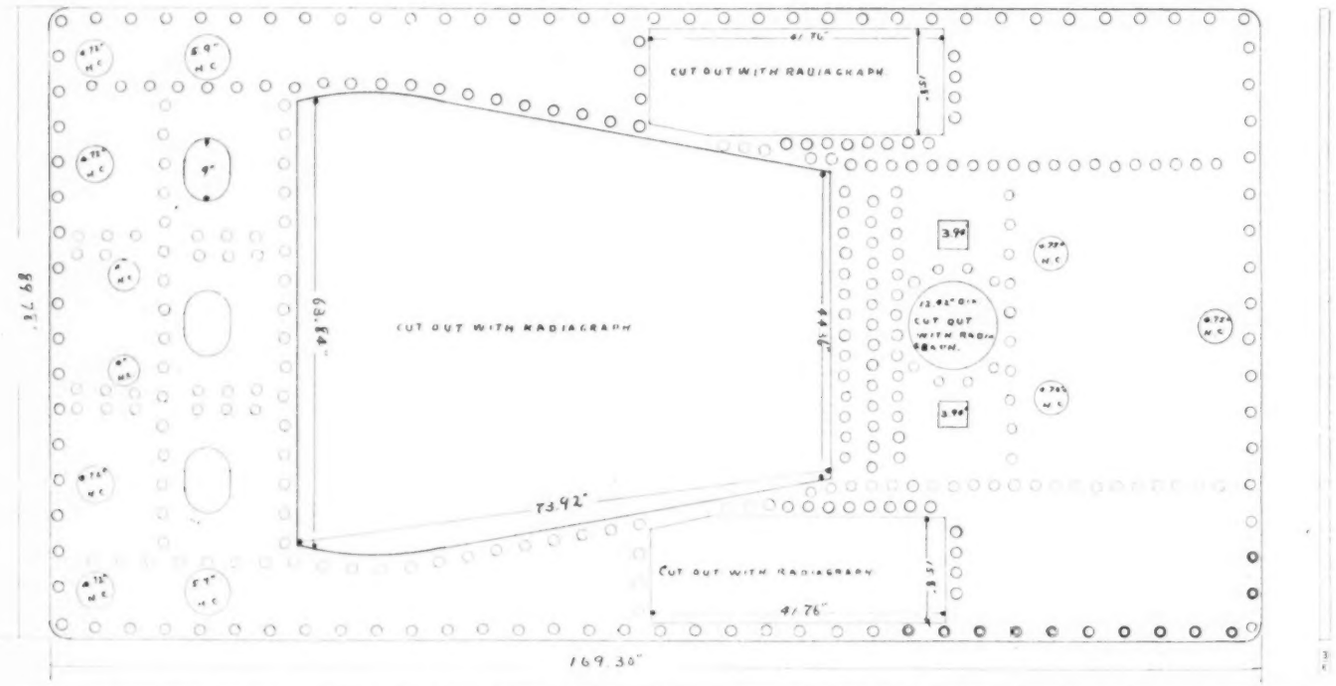

Fig. 6. Bottom plate for gun carriage. All of the squares, circles and ovals were cut with the machine. Special tracks were built for the irregular cuts in both top and bottom plates.

Electrolytic Oxygen-Hydrogen Cutting

The photograph shows a steel shaft head 18 inches in diameter cut in two in six minutes. Oxygen consumed, 22 cubic feet; hydrogen, 11 cubic feet. Total cost of gases, 38½ cents. The electrolytic oxygen-hydrogen flame is the cleanest, swiftest, lowest-cost cutting medium.

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Get Electrolytic Oxygen and Hydrogen

Obtainable at the Following Service Stations:

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COLORADO
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ILLINOIS
National Oxygen Co., Chicago
Acme Oxygen Co., Chicago
Burdett Oxygen & Hydrogen Co., Chicago
Electrox Co., Peoria
Swift & Co., Chicago

INDIANA
Indiana Oxygen Co., Indianapolis
Logansport Oxygen Co., Logansport

IOWA
Bettendorf Oxygen Hydrogen Co., Bettendorf

KENTUCKY
Kentucky Oxygen & Hydrogen Co., Louisville

MICHIGAN
Michigan Ox-Hydric Co., Muskegon
National Oxygen Co., Detroit
Burdett Oxygen Co. of Detroit, Detroit

MINNESOTA
Commercial Gas Co., Minneapolis

MISSOURI
Oxygen Gas Co., Kansas City (two plants in Kansas City)
St. Louis Oxygen Co., St. Louis

MONTANA
Mountaineer Welders Supply Co., Butte

NEBRASKA
The Balbach Company, Omaha

NEW YORK
Standard Oxygen Co., New York City
International Oxygen Co., College Point, L. I.

NEW JERSEY
International Oxygen Co., Newark
Standard Oxygen Co., Hoboken

OHIO
Burdett Oxygen Co. of Cleveland, Cleveland
Ohio Chemical & Mfg. Co., Cleveland
Dayton Oxygen & Hydrogen Products Co., Dayton
Ohio Electrolytic Oxygen Co., Cincinnati
Clarke Chemical Co., Wickliffe

OKLAHOMA
Burdett Oxygen Co. of Oklahoma, Oklahoma City

OREGON
Portland Oxygen & Hydrogen Co., Portland

PENNSYLVANIA
International Oxygen Co., Verona
Burdett Oxygen Co., Philadelphia (Plants at Chester & Norristown)
Burdett Oxygen & Hydrogen Co., Pittsburgh
National Oxygen Co., Erie

TENNESSEE
Burdett Oxygen Co., Chattanooga

TEXAS
Burdett Oxygen Co. of Texas, Ft. Worth
Magnolia Gas Products Co., Houston

UTAH
Whitmore Oxygen Co., Salt Lake City
Utah Burdett Oxygen Co., Salt Lake City

WASHINGTON
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GAS PRODUCTS ASSOCIATION

801 Marquette Bldg., Chicago, Ill.

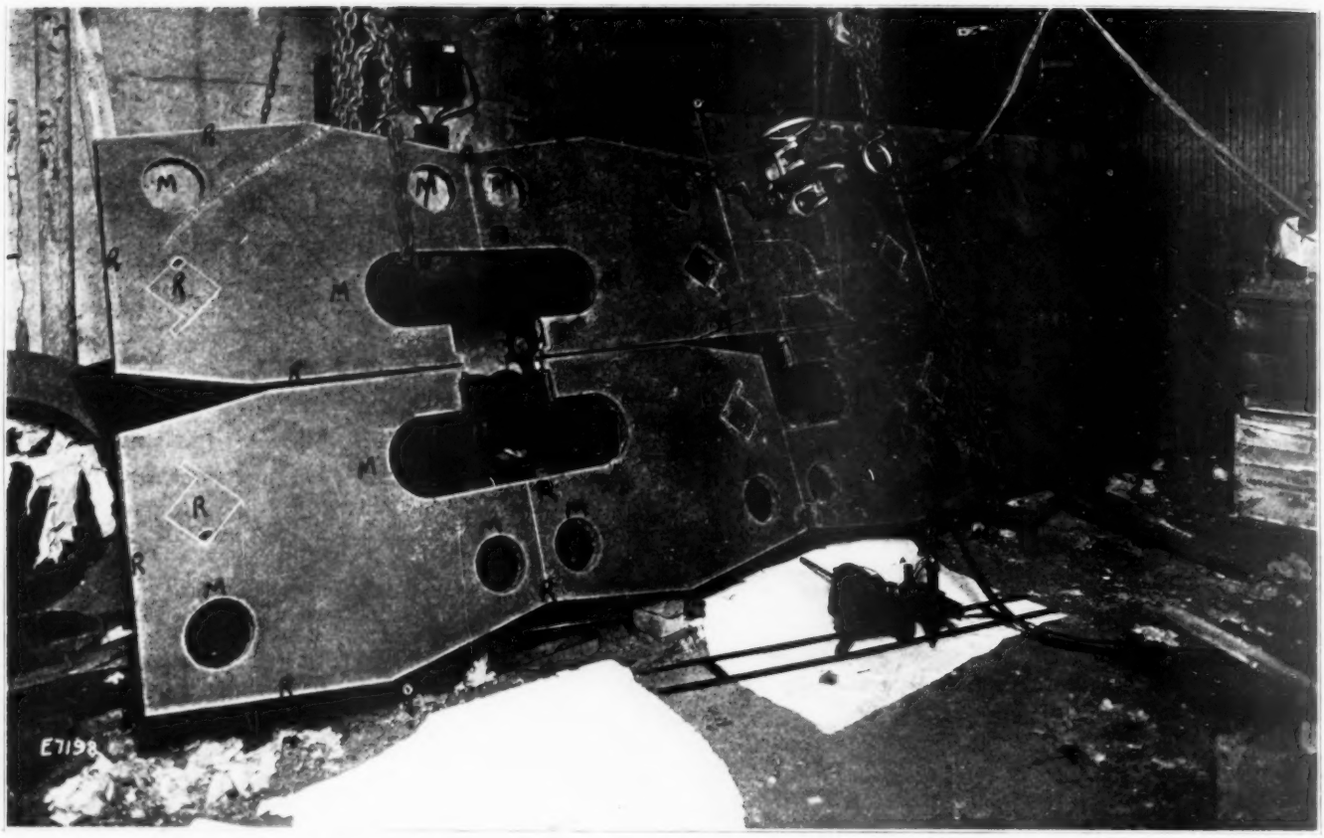


Fig. 7. These pieces after being cut are used for housings for punching and shearing machines. The finished machine, for which these housings were made, is illustrated in Fig. 18.

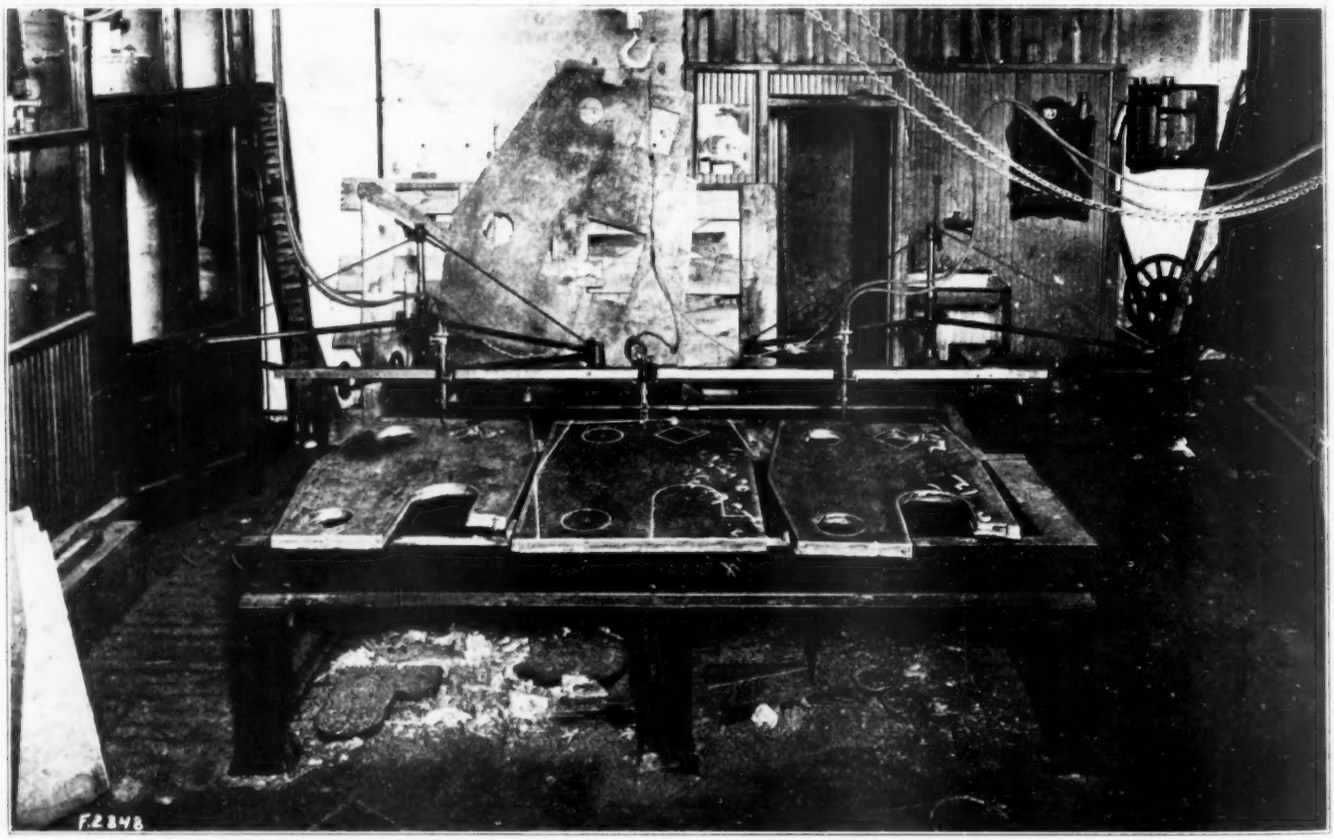


Fig. 9. Cuts made in two plates in one operation by use of No. 2 Oxygraph. Machine in operation will be seen in Fig. 8.

s shown in Fig. No. 4. The flanges were cut inside and utside with the Radiagraph at a speed of 6 in. per minute. The flue sheet was cut on outside only, also at a speed of in. per minute, and after cutting it was found that no machine work was required at all. Due to the machine cutting operations performed on these sheets it was not only possible to complete the contract at the time set by Government Officials, but enabled us to complete the entire order

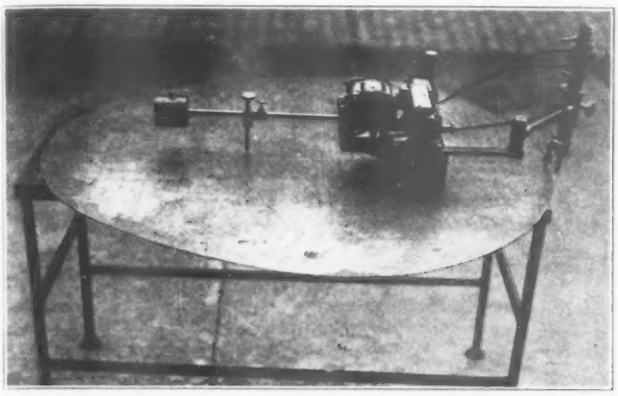


Fig. 10. Radiograph rigged up for making irregular cuts.

before the time allotted. At left of Fig. 4 the machine is completing a cut on flange, and at right flue sheet is already cut. The smoothness of these cuts can be plainly seen.

Figs. Nos. 5 and 6 show some remarkable cutting on Top and Bottom Plates of Gun Carriages that was accomplished by Machine Cutting that were cut .015 of an inch to line, and clearly illustrates how close machine cutting can be done if machine is properly rigged and set up. These plates were .375 of an inch thick, 169.30 in. long and 89.78 in. wide. Fig. 5, Top Plate for Gun Carriage, shows center piece cut out, and also a circle 12.602 in. in diameter cut out with the Radiagraph. It will be noted that the right side of this center piece is cut to a radius of 98.03 in.; also the top and bottom of right end is cut to a radius of 94.22 in. The balance of center piece is straight cutting. To accomplish this accurate cutting, special tracks were constructed the

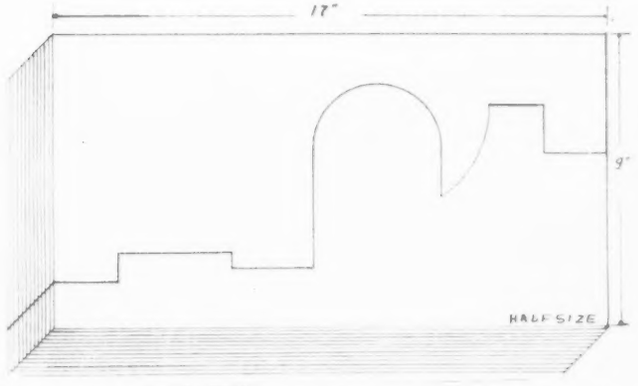


Fig. 15. Illustrating the extreme irregular lines cut with the No. 1 Oxygraph. Twelve plates cut in one operation.

same length and shape of the three uneven cuts to guide Radiagraph, and a straight track used for cut at left. The tracks were bolted to plate and the cutting then started. A plate cutting tip, Style No. 206, was used on all this cutting. There were 24 lineal feet of cutting on this plate. Fig. 6 shows Bottom Plate for Gun Carriage. These plates were .375 of an inch thick, 169.30 in. long and 89.78 in. wide. All the circular, square and ovals were cut out with the Oxy-Acetylene process, and were also cut .015 to line. The top and bottom cuts on center piece at left of drawing was cut to a radius of 32.91 in., the balance of center piece was straight cutting. Special tracks were also built for this irregular cutting and straight tracks for balance of straight line cutting. The balance of cutting was accomplished with

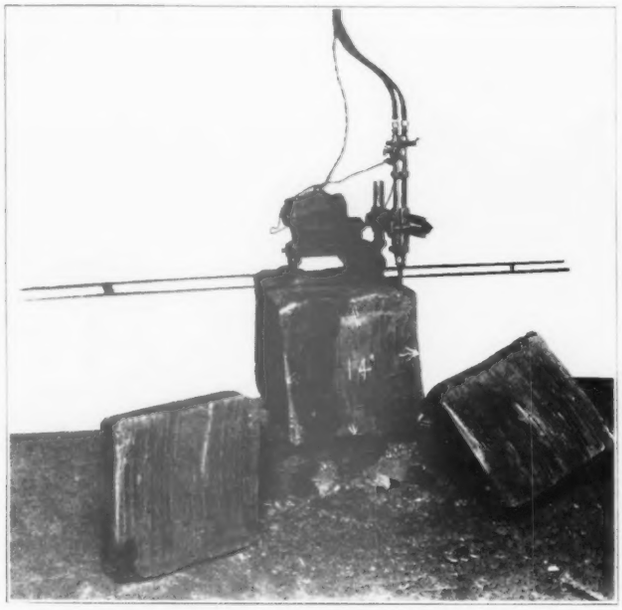


Fig. 13. Billet cutting by machine. This billet is 14 inches square an two cuts were made in 13 minutes.

regular standard equipment. The total amount of lineal feet cut on this plate was sixty-three (63). Style No. 206 Plate Cutting Tip was used.

Engineers familiar with Government requirements during the war will appreciate the wonderful performance of these machines on these plates; the uses they were intended for called for spending up of production to its limit, and it cannot be questioned that this cutting could not be anywhere near duplicated as to Time, Cost and Accuracy.

Figure 7 shows cutting on a steel plate 1½ in. thick, 204 in. long and 67 in. wide. These pieces after being cut are used for housings for quadruple punching and shearing

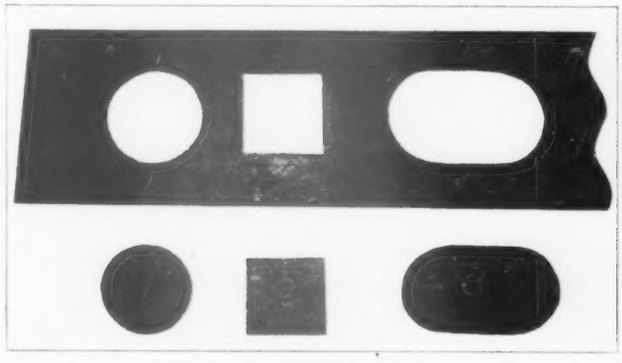


Fig. 12. Irregular cuts on ½-inch plate.

machines. When the contract for this cutting was placed, one of the items particularly noted called for cutting by the Oxy-Acetylene process, all cuts to be within .0625 in. to line, so as to eliminate as much machine work as possible. Cutting so close to line could only be done by taking away as much of the human element as is possible, making all cuts by machine, and the only human element necessary was for some one to start and stop machine. The machines that did the cutting can be seen in the foreground,—A Radiagraph set on tracks at bottom of plate, and the Magneto-

graph is magnetized to plate at top center. The zigzag cutting on top and bottom edges of plate were cut with the Radigraph, by placing the track on which the machine is guided when in operation to make straight line cuts that produces the zigzag result. All cuts marked "R" were made with the Radiagraph and those marked "M" were made with the Magnetograph. This machine is held to the plate with three magnets. Circles can be cut from 2 in. to 12½

Fig. 17. Three-inch high grade die steel. Note smooth, clean cuts.

in. in diameter, and the machine can be attached to a vertical or horizontal surface of steel plate by turning on switch. The total amount of lineal feet of cutting on each plate is fifteen.

Figure 8 shows how production can be increased without additional labor costs. This shows the No. 2 Oxygraph cutting two plates at one time with only one operator. It will be noted that the power driven tracer is following the markings on template in center, while a torch on each end is actually cutting the plates simultaneously. There are 15 lineal feet of cutting on each plate, and speed of cut is 13 in. per minute. Fig. No. 9 shows both cuts completed, also template in center. The motor and tracing wheel can be plainly seen in center of template.

Figure No. 10 show how Radiagraph is rigged up for making irregular cuts and is being used for trimming flanges on Scotch Marine Boiler Tubes as per Figure No. 11. These cuts are oval shaped and have about nine radii. The former method of trimming was by hand cutting and finished for caulking by chipping. The Radiagraph is set to travel around a true circle while the torch is held close to the template by a spring. This cutting is being done so smooth, clean and close to line that no chipping or grinding is necessary after torch finishes cut, as the caulking edge is not

Fig. 16. Plates shown in Fig. 15 stacked up on Oxygraph after cutting. Operator is guiding motor driven tracer over drawing.

injured by flame, on account of speed of cut, and type of tip used. Figure No. 10 clearly illustrates how irregular cutting is being done by machine equipment, as the template, special arm, and spring can be plainly seen. Figure No. 12 shows this type of cutting on one plate ½ in. thick; this shows a circle, square oval and on right end an irregular cut with six different radii, template being used on all cuts but the circle.

Figure No. 13 shows billet cutting by machine equipment, and plainly indicates how smooth and clean this class of work is being done. Billet is 14 in. square and two cuts were made in 13 minutes.

Figure No. 14 shows a fishing tool after being cut with No. 2 Oxygraph. This tool is used in the digging of oil

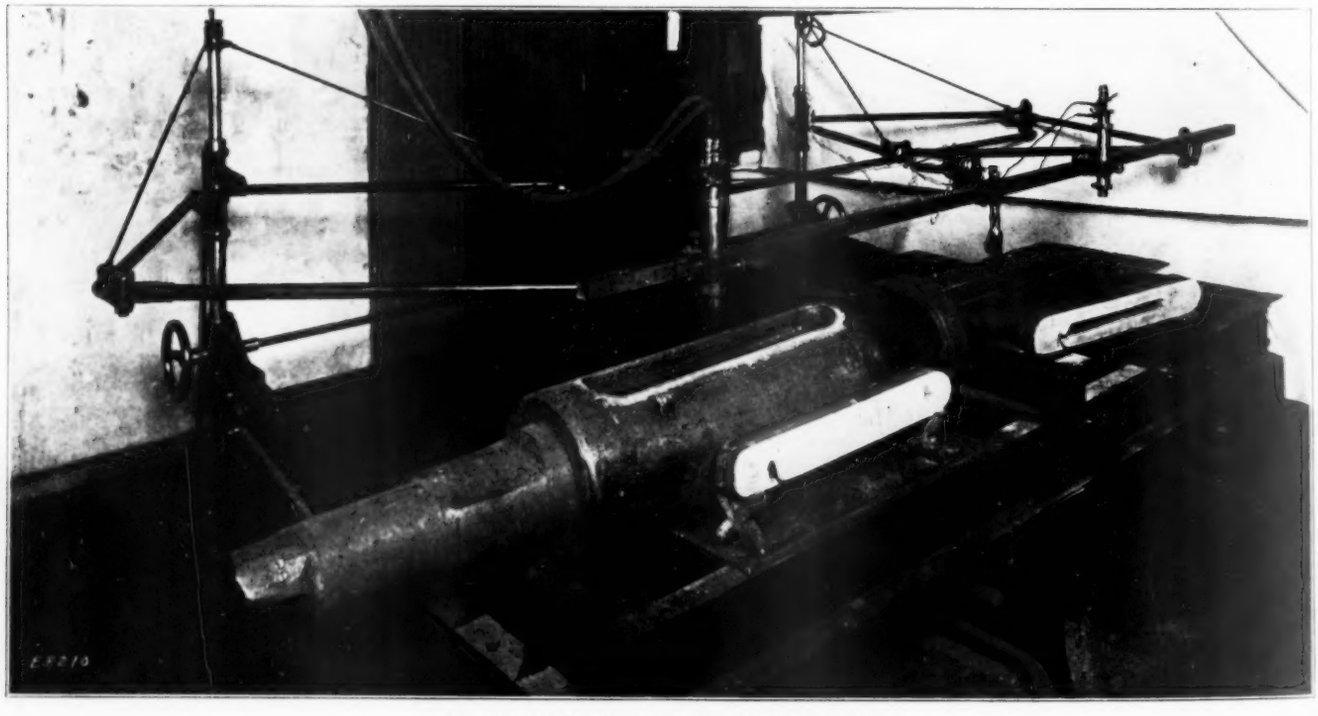


Fig. 14. Fishing tool cut with No. 2 Oxygraph.

wells for fishing out broken tubes. There were two cuts made on this tool, each one having ten lineal feet of cutting, 2½ in. thick; the combined time for two cuts being 21 minutes, and weight of tool being 900 pounds. The old method employed to do this was to cut each piece out by hand torch and then machine the round ends. The motor driven tracer wheel can be seen on template on right of picture.

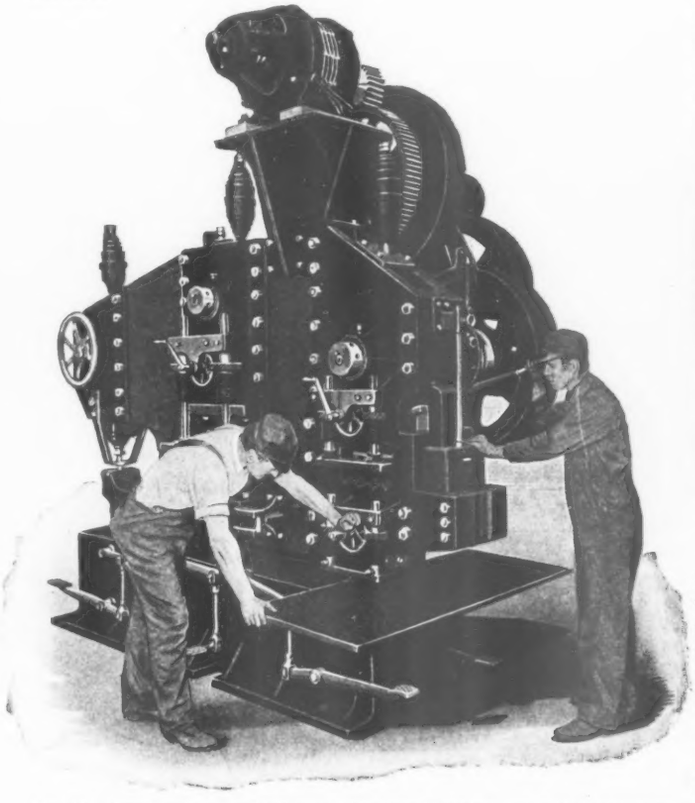


Fig. 18. Quadruple Punching and Shearing Machine for which housings shown in Fig. 7 were cut. This machine is manufactured by Joseph T. Ryerson & Son, Chicago.

Figure No. 15 shows to what extreme irregular lines can be cut with the No. 1 Oxygraph. These pieces are used in wheelbarrow construction, and were cut twelve pieces at one time by piling one on top of each other and then holding them together with one bolt in center.

Figure No. 16 shows these plates stacked up on Oxygraph after cutting. In the foreground, operator can be seen guiding motor driven tracer over drawing. Cutting speed at rate of 108 in. per minute on single plates.

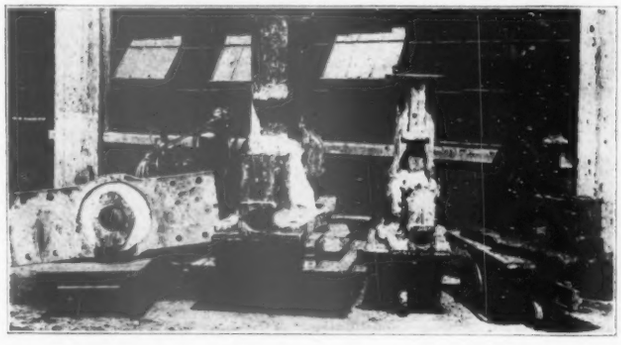
Figure No. 17 shows the kind of cutting that is being done with this machine, all cuts being smooth, clean and straight, and we re cut .015 in. to line, the material being high grade die steel, 3 in. thick.

The writer hopes that this article and illustrations will be of interest to our trade in general, and in his next article will endeavor to describe some machine welding operations that I am sure are more wonderful, if that is possible, than those illustrated in this article.

LARGE CAST IRON WELDING.

One of the most interesting and successful heavy cast iron welding jobs is being handled in Detroit at the plant of Dodge Brothers under the supervision of Mr. J. S. Jacobs, welding supervisor.

His method of handling this work, which is a large steam hammer cylinder varying from 3 to 5 tons each, is to first drill into the crack with a 2-inch drill within about ½-inch of the bore of the cylinder. This can best be accomplished with a radial drill press. He then inserted in the bore of the steam chest a 7-inch shaft, allowing same to stick out over the end of the casting. The cylinder is then picked up by electric crane and placed in an oil burning furnace made out of firebrick. A shaft is set on the blocks at each end of the furnace so that the casting can be conveniently turned. The top of the furnace is covered with plates of asbestos ¾-inch thick, in sections of 1½ feet in width by 2 feet in length, so that the furnace can be opened at any place by simply taking out one of these sections. The idea of these sections is so that one at a time can be opened to allow the welding operator to insert his torch. The furnace is heated with crude oil with the open bottom furnace



Steam hammer cylinder welded under supervision of J. S. Jacobs.

so that the flame and air will not strike directly on the cylinder. The heat is applied so that the casting is brought up to 1,000 degrees of heat in about 15 hours. This degree of heat is maintained for reasonable time and then the furnace is shut off and the welding operation is started, which requires about only two hours of actual welding. When the weld is completed the furnace is covered up tight and allowed to heat until the casting once more attains the uniform heat of about 1,000 degrees, after which the furnace is allowed to cool for about 36 hours. The operators are provided with 14-inch asbestos gloves and goggles that are not affected by heat.

The information to be gained from this article is that the welding is a small end of the job. The important factor is in the preheating and placing of the job in the furnace so that it can be handled with reason.

The object of this article is to impress upon welders that there are more failures on large jobs through improper handling and preheating than there are in the welding, and there can be no doubt but that this theory is absolutely correct.

REGULATORS AND TORCHES.

The most neglected parts of the oxy-acetylene welding and cutting equipments are generally the gas pressure regulators and the torches. Many operators entirely disregard the instructions given them regarding the use and the care of these instruments. Welding should be recognized as a trade but there certainly must be some requirements demanded of welders besides the ability to weld metals. Any welder worthy of the name should be familiar with the construction of the apparatus intrusted to his care, and should feel obliged to use them with the same care and consideration as the mechanic uses his machinery, tools and instruments. Just as easily as one can distinguish the scrub machinist from the real, dependable mechanic by the quality of his work and by the way he keeps his tools in order, so can the good welder and cutters be told from the metal melters and burners. It is a joy to find welders and cutters who take good care of their apparatus and fortunately many or them do.

TRAINING STUDENT WELDERS.

By Ed. J. Hardy

To meet the requirements of an ever-increasing demand for oxyacetylene welders, the Cass Technical High School of Detroit, Mich., has expanded to include a department of oxyacetylene welding. This department consists of day and night sessions. The classes are under the direction of Eli A. Berkley.

The shop is 30x74 feet and has 26 stations. The oxygen is piped from a central source at which point Airco

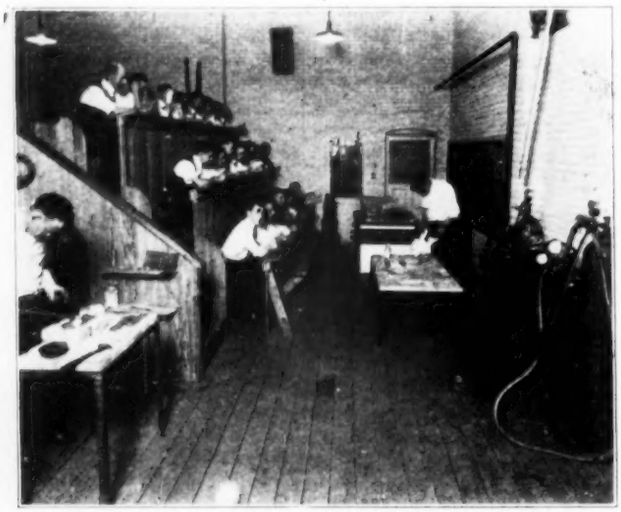


Fig. 1. Instructor E. A. Berkley With Class in Welding Lecture Room.

cylinders are connected to the line by two ten-tank manifolds. Each station occupies six square feet and consists of a 232 cubic foot Airco acetylene cylinder, a welded angle-

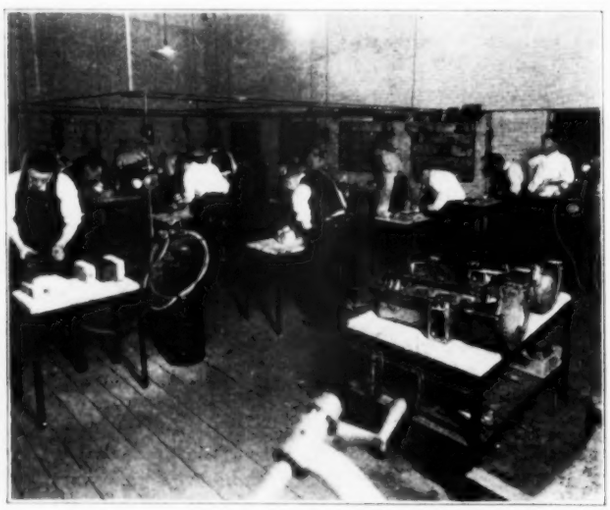


Fig. 2. Section of Welding Class in Detroit Cass High School Welding Department.

iron table with fire brick tops, torches, regulators, hose, etc.

Under the present schedule classes are held from 9 A. M. to 1 P. M. on Monday, Tuesday, Thursday and Friday of each week and every week day night from 7 to 10 P. M. All classes are completely filled and there is a waiting list of eighty, to which names are being added daily.

The personnel of the classes is largely made up of welders and mechanics employed in the various Detroit industrial institutions. Many who have been doing production work are taking the course to perfect themselves in other branches of welding. Cast iron welders are learning aluminum, steel and job welding, while those who have been specializing in sheet metal, or some other line, are applying their time to whatever branch of the welding trade they wish to perfect themselves in. The advantage of this can readily be seen, for as a welder becomes more proficient and the range of his adaptability more extensive he increases his usefulness to his employer to just that extent.

The course of study is divided into two parts. The first consisting of 24 lessons, of three hours each, is planned to give the student a general knowledge of the subject, covering oxyacetylene welding equipment, use and care of same, and the welding of cast iron, steel, brass, aluminum and brazing. Exercises are given the student for practice, which occupies at least two-thirds of each three hour lesson.

The second part of the course is covered in 24 lessons, and takes up the more advanced problems. A student may specialize in one line of welding if he wishes—sheet aluminum, sheet metal, general job work, etc. Less time is given to

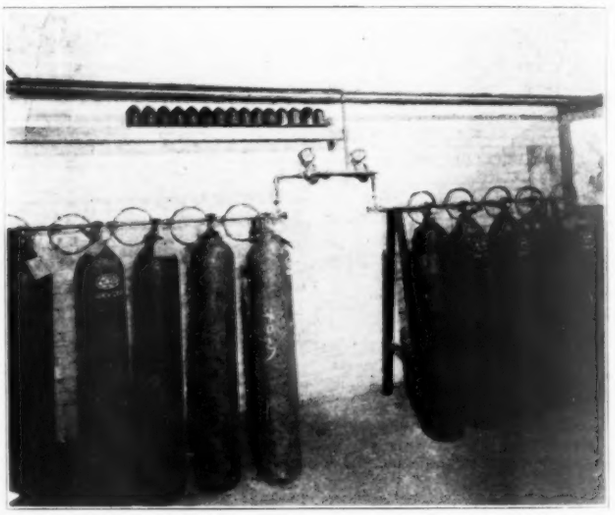


Fig. 3. Oxygen Is Piped to Each Welding Table From a Central Source, the Cylinders Being Connected Up in Manifold.

lecture work by the instructor and more time to practical demonstrations and the handling of difficult repair jobs such as where contraction and expansion figure as the perplexing problem.

A good amount of general repair work of all kinds is furnished by the City Engineers' department, and as soon as the student has demonstrated his ability to undertake a real job, he is allowed to take hold of this work. However, until the student reaches this stage of ability, he must work on exercise stock, watch the demonstrations of the instructor and the work of others. He is required to perform each operation satisfactorily and is given personal attention to assure best results as he progresses. The work when finished is inspected, criticized, and suggestions offered where improvement in handling and finishing is deemed necessary. Whenever advisable the weld is broken and the fracture is examined. If any interesting points can be brought out the class is given the advantage of such suggestions.

The shop is arranged with a large lecture and demonstrating room in one end, where efforts are made to combine the application of the practical and the theory. This room is equipped with a pre-heating furnace, welding table and other equipment necessary to carry any job through to its completion.

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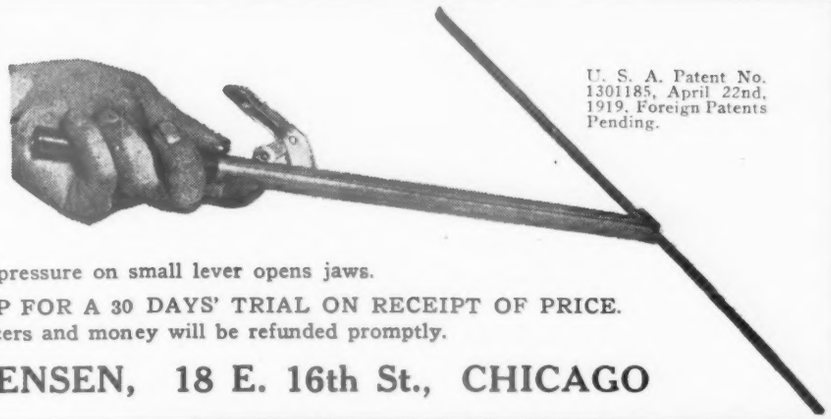

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By Lieutenant Lorn Campbell, Jr.
Ordnance Corps, U. S. A.

Lieut. Campbell organized and conducted the Army Welding School at Peoria, Ill. His new manual is based on his experience there, in training soldier welders. 154 pages, 89 illustrations, bound in cloth, $1.25.

THE WELDING ENGINEER
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(Continued from Page 38)

It must be remembered that everything in the electrode goes into the weld, and if the electrode is imperfect and contains slag and dirt, the weld will also contain these same impurities. Further, the tremendous oxidation undergone by the iron as it passes through the arc is detrimental to the quality of the weld. This does not mean that this method of welding is not suitable for many purposes because it is, and is successfully used. The writer uses it every day for such purposes as filling up holes that have been drilled wrong, for filling up worn key seats, for replacing metal where too much has been removed in machining, and in many other places where its use is entirely satisfactory.

The advantages of the electric weld are its low cost and the speed with which it can be made. Its principal disadvantage has been referred to before, and that this is its brittleness. There are many places where this is not detrimental, and if there is enough suitable work to warrant the installation of an electric welding outfit, its use will be found economical. One matter which should be watched closely in connection with electric welding is the effect of the high temperature and its sudden application to steels containing, 0.4 per cent carbon. It has been found that in such steels, particularly where the piece welded is of considerable size, the quenching effect of the cold metal produces a zone of sorbitic character next the weld, which may start a detail fracture under alternating stress. The work referred to is of the nature of adding material to worn shafts in order to turn them up again to the proper size. While the welding is successful, the alteration of the structure is dangerous. This difficulty can be readily overcome by preheating the shafts to a high enough temperature to prevent the formation of the brittle zone. This temperature would depend on the size of the shaft, being less for a large shaft than for a small one. The slow cooling, due to the preheating, prevents the formation of sorbite and no trouble is experienced.

With oxy-acetylene welding, this defect does not exist, as the piece being welded must be brought to a high temperature before any welding is done, and this is sufficient to anneal the material near the weld.

Breaking Welded Pieces by Test

In making tests of welded pieces, it is essential to know the qualities of the material being welded if fair comparisons are to be made; for instance, in very soft material having a tensile strength of about 50,000 lb. per sq. in., where the weld is of the same section as the rest of the piece, the chances are that a sound weld made by either process will be strong enough to break the original material, so that the figures obtained are those of the original material and not those of the weld. On the other hand, if the original material is of 60,000 lb. tensile strength the chances are that even with the weld somewhat reinforced the break will take place in the weld. The writer feels it necessary, therefore, to measure the elongation not only in the total gage length, but in each inch between the gage marks in order to be sure of what the figures do represent. In the results given above for oxy-acetylene welds, the yield points are those of the welds, while in the tests given below for electric welds the yield points are those of the original material.

	T. S.	Y. P.	Elongation in center 2in.	Broke
Electric Welds	51,200	.....	.....	Outside Weld
	51,600	31,300	.....	Outside Weld
	51,300	33,300	7.5 per cent	Inside Weld
	50,500	32,200	7.0 per cent	Inside Weld

As stated before, the elongation of electric weld material itself is very low and the yield point, therefore, is very close to the ultimate strength. It will be noticed that the elongation is very small, and an examination of the test pieces will show that most of it is in the original material.

While it is not always of great importance in the repair of drop forgings to consider the character of welds with regard to their soundness, because usually welds are not made in parts which require great care in order to get the best results. It may be of interest to know that in the writer's experience the quickest and easiest way of determining a welder's ability is to have him weld together two pieces of ½ x 2-in. ordinary bar steel in the case of gas welding, or two pieces of ½ x 3-in. bar steel in the case of electric welding. The reason for using the wider piece in electric welding is that both the beginning and end of an electric weld are liable to be bad for ½-in. from the edge. The beginning is bad because the temperature has not been raised to the proper point, and the end is bad because the temperature is too high. With oxy-acetylene welding, the temperature at the beginning and end can be regulated by the operator. The electric weld should be machined off for ½-in. on each side, leaving the piece about 2-in. wide. If such pieces are then clamped on an anvil or heavy block, so that the bottom of the V is on a line with the face of the anvil, and the projecting part of the piece is struck with a sledge, a very good and rapid test can be made of its quality.

It will be found that electric welds are very brittle and will not give much bending, while gas welds will bend down flat and will even stand further bending before cracking on the outside of the weld if they are properly made. An examination of the fracture will indicate the mechanical soundness of the weld. Beyond this the welder cannot go, as he has but little to do with the metallurgical character of the weld.

Welding Heat Changes Structure.

The physical structures of welds are of great interest and importance. In most cases they are what would naturally be expected from the high temperatures involved in the welding operation, but in the oxy-acetylene welds made with ordinary material, the weld is coarse grained, and, on account of the distribution of the heat, the grains are approximately equiaxed. Most of the carbon has been burned out by the heat so that what is left exists as isolated particles of cementite at the grain boundaries, as in very low carbon steel. There is always present more or less oxide, which is readily seen in an unetched section as small round dark dots. There are frequently minute holes probably caused by the escape of occluded gases during cooling. Especially in the tops of welds made with a heavier tip than necessary, there are plates and needles of what is probably nitride of iron, due to the combining of the nitrogen of the air with some of the iron. The material next the weld is coarsened by the heat and somewhat decarbonized for some distance below the original surface. Between the body of the weld and the original material there is a zone of gradually changing carbon content, as would be naturally expected. In this zone, unless proper fusion has occurred, there are liable to be films of oxide of great thinness, which are not visable in the polished section but which etching shows up distinctly. These films are of the order of a 1/50000 in. thick, and have the effect of causing the weld to break along the line of the V; greatly decreasing its tensile strength and elongation; they are also fatal under alternating stress. Similar defects are liable also to be in the body of the weld where it has been poorly made; but they do not exist in any place in a properly made weld. The burning out of carbon and the presence of oxide dots cannot be avoided, and they are the only defects which should exist in a good oxy-acetylene weld. The nitride of iron is probably of little importance, as far as ultimate strength is concerned, although it may have some effect on the elongation, and, as it should not exist in a good weld, its effect can usually be neglected.

Electric welds have the same general characteristics as oxy-acetylene welds, the difference being in degree only. The grains are frequently columnar, their log axes being perpendicular to the surfaces of the Vs in the original material. The layers of

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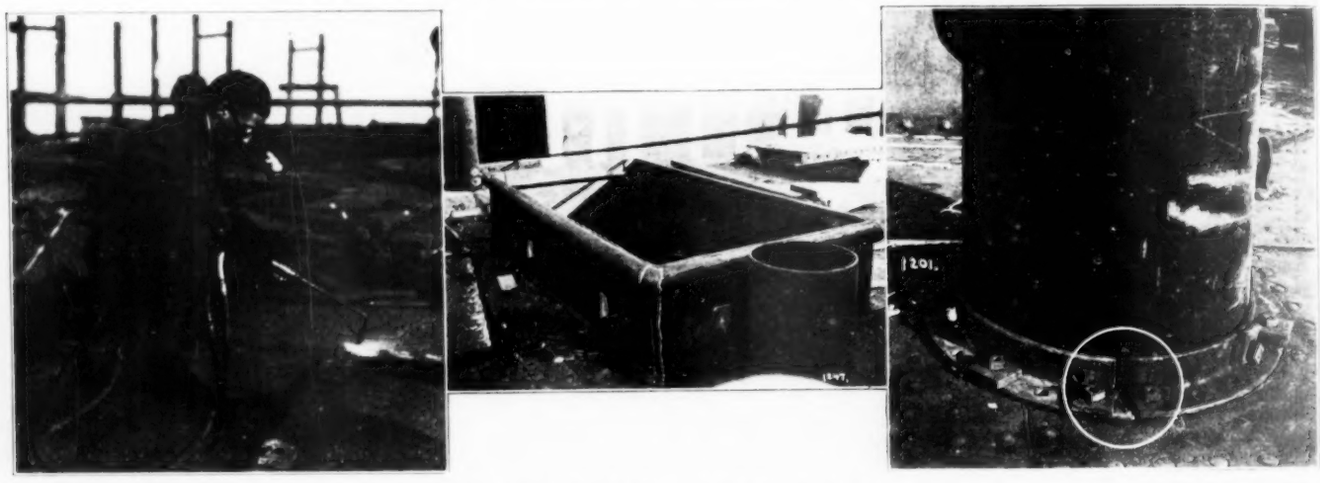
metal applied later refine the grain of the first layer, changing the columnar structure to an equi-axed one, so that some discretion must be used in interpreting this and other features of such welds. The reason for the columnar structure is the very rapid cooling due to the great localness of the heat. The same result is produced in ordinary steel ingots by the cold walls of the molds. The coarsening of the grain in the original material occurs in electric weld as well as in oxy-acetylene ones, but to less extent because of shorter time of application of the heat. In all fusion welds there is a zone at some distance from the weld line in which the grain is much finer than in the original material. This zone is further away from the weld with the oxy-acetylene than with the electric process. Its distance varies with the thickness of the piece, being greater with thicker pieces, and is about 1½ in. in the case of a gas weld made in ¾-in. steel plate. Electric welds contain larger amounts of oxide than do oxy-acetylene welds, and they are also much more subject to defects in the form of oxide films and slag pockets for reasons already explained.

Nitride of Iron in Arc Welds.

The special difference between electric and oxy-acetylene welds, however, is in the presence of large amounts of nitride of iron, which, as explained before, is caused by the nitrogen of the air combining with the iron at the very high temperature of the arc. Although this material has not been isolated as yet, a comparison with material that is known to be nitride of iron leaves little doubt of its identity. Nitride of iron resembles cementite very strongly with ordinary etching, although it does not blacken with sodium picrate etching, as does cementite. Nitride of iron when present in sufficient quantities apparently forms a eutectoid with iron which very much resembles pearlite. All steels contain some nitrogen, but because there are many difficulties in the way of making analyses, not only for nitrogen, but for other gases or their compounds, and in view of the newness of the subject it is not to be wondered at that there are no accurate data as to the amounts of nitrogen in welds. Reasoning from analogy, however, it is probably that the average electric weld contains something in the neighborhood of 0.2 per cent nitrogen which, if the formular of iron nitride be Fe_2N, would give 1.8 per cent iron nitride. The appearance of an electric weld would lead one to believe that there is at least this amount of iron nitride present. The appearance of iron nitride varies from that of exceedingly thin plates of brilliant white material to masses of some size, and still further to the eutectoid referred to above. The plates are exceedingly thin, being probably at times of the order of 1/100000 in. thick, and in many cases they appear in an etched section as dark lines of some thickness, but this is doubtless due to the acid eating off the corners of the metal next to the plates and making a groove which of course shows dark in the microscope. These plates lie along the same planes in the grains as do Neumann lines, and do not lie along the slip planes. It is doubtless for this reason that they have but little effect on the strength or distortion of an electric weld. As the amount of nitride increases, it collects in large masses which finally appear as eutectoid. In the writer's opinion, these masses of iron nitride contain some iron carbide because parts of the spots darken with sodium picrate etching or with heat tinting, while in pure iron nitride there appears to be no such effect.

Reference has been made to the path of rupture in welds. As a comparison it may be stated that in sound iron or steel this path is always through the grains along the slip planes. In sound oxy-acetylene welds made with usual welding materials, the same path is followed, while in electric welds the path is, within the writer's experience, always along the grain boundaries.



At left, welding the butt of a door frame. Center, welded hatch coaming corner. Right, split deck collar on L-ring ready to be welded.

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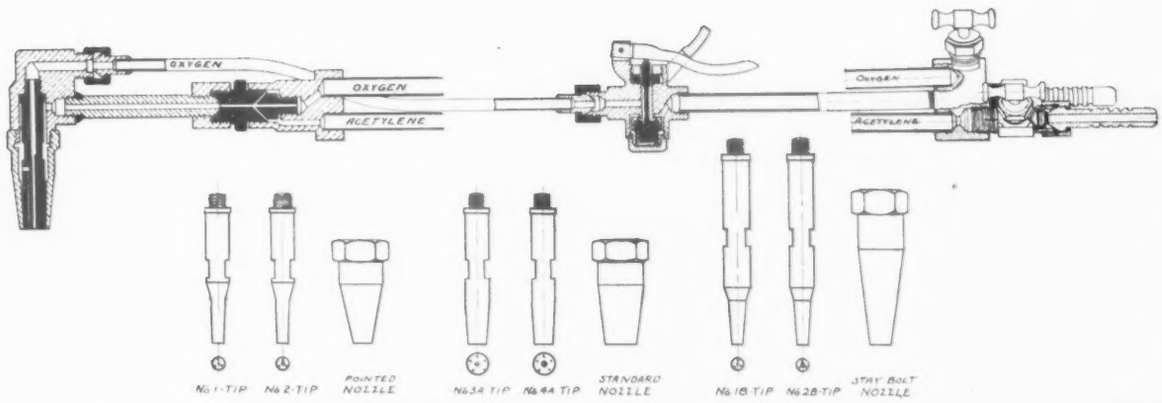

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Position Wanted—An all around acetylene welder, brazer and cutter. Over seven years' experience in car shops, railroads, boiler and tank shops, jobbing shops, construction shops, foundries, pipe lines, pipe fittings, etc. State wages. M. J. Quigley, West Carrollton, Ohio. 1t-Nov.

Wanted—Slightly used welding and cutting apparatus. Any quantity. Any make. Also generators and supplies at the right price. Apply Box T, care The Welding Engineer. 1t-Nov.

Position Wanted—Practical welder will handle and demonstrate around New York City, new, worth while articles and supplies for the welding shop or welder. What have you? A. F. Norton, 6 Arlington Avenue, Brooklyn, N. Y. 1t-Nov.

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Position Wanted—First-class electrical welder with experience on both A. C. and D. C. machines desires position as foreman. Has had experience in ship and repair work, also as instructor in arc welding school. Possesses good education and is capable of handling men. Good references. M. F. Sheely, care Electric Arc Cutting & Welding Co., 222 Halsey St., Newark, N. J. 1t-Sept.

Soldier Wants Job—Former sergeant, Ordnance Corps, just returned from France wants job as welder. Have had plenty of experience. A. W. Davis, General Delivery, Lawrenceburg, Tenn. 1t-Sept.

Position Wanted—Have had experience with general welding in car barns. Last year in charge of sheet metal work. Want chance for advancement. Will go anywhere. Address Eric A. Ohlson, 30 Riverview Street, Brockton, Mass. 1t-Sept.

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CUTTING

So much attention has been given to welding, so closely related inasmuch as the principle of combustion is concerned, that it has induced more persons to study the art, but with the cutting process it has been unfortunately the reverse. There are no doubt, *less than ten per cent of the operators of cutting torches at the present time who understand the action of their flame;* the limits of their skill being in guiding the torch along a chalk line and burning the steel, thereby severing the pieces. They cherish the idea that the force of the oxygen alone, against the steel carries out the cutting.

One of the principle reasons for these conditions being that superintendents and foremen know as little about the cutting process as do the operators themselves, and cannot therefore, detect good work from bad.

This results in having the art remain always on the same plane. Another reason, also due to lack of knowledge of the prerequisites of an operator, is, that the *burner* is extracted from amongst the helpers of different classes of mechanics, and is, more or less, without skill in the use of any tool, let alone a cutting torch. The desire to handle a torch is enticing to the average helper and he applies to his foreman for the next opportunity to learn the operation of a torch. The foreman who considers it only an untrained mechanic's job, and the superintendent anxious to keep the wage scale as low as possible, deem it a good move to "let the young fellow have a chance." After a week or more of breaking in with a fellow *burner* he is given an outfit of his own and is proclaimed eligible to *burn*. He daily learns to cut faster, and *in his own opinion* better, but he never knows *why his torch cuts*, for few of his class understand the seemingly mysterious action of the cutting flame.

While it is not necessary that persons should be drawn from the welding ranks, it is necessary that students or apprentices should be instructed in the use of the torch by skilled instructors or operators.

The advantage of cutting steel by this process over that of any other method is unquestionably in its favor. Steel of any thickness can be cut into any shape with speed varying from four to twenty inches or more per minute at a decided saving in both time and labor over all other methods.

For cutting steel and wrought iron the oxy-acetylene process has practically no competitor, it being impossible with the carbon point to cut as fast or as fine and neatly as the gas torch, although for cutting up scrap the carbon point is cheaper if time is no object and labor cheap.

Cutting with the electric carbon arc is no more than a melting process leaving a very wide and irregular cut.

It is true that the cutting torch is on a par in usefulness with the pneumatic hammer and its use would be as indispensable as the latter in every case.

It has taken these past four or five years to bring it to its present state of efficiency, the welding and cutting equipment so essential to the proper manipulation of the oxy-acetylene flame, so that now it is not a question of better instruments but to what new line of manufacturing can be made to serve for both welding and cutting.

The most essential factor in the accomplishment of a good cut is the use of pure oxygen. This fact cannot be dealt with too much. It has been ascertained that oxygen containing as little as eight per cent of foreign gasses is unfit for cutting. The majority of superintendents and foremen in plants where the process is being used extensively have not had it made clear to them either by demonstration or explanation, the value of the use of pure oxygen.

To their knowledge, oxygen has always been oxygen. Pure oxygen can be purchased as readily as impure oxygen and the value of it over the poorer quality should discontinue the use of impure oxygen entirely. Discrimination in the purchasing of oxygen will eventually reduce the cost of cutting almost sixty per cent of its cost. From this it is meant the savings in the quantity of oxygen used, the expense of chipping slag from the line of cut, reduced speed in cutting, handling of extra cylinders, and numerous other drawbacks which follow the use of the cheaper quality oxygen.

Pure oxygen oxidizes more of the heated metal and much faster than does impure oxygen. More oxide is therefore completely consumed, which leaves the cutting line free for the rapid advance of the cutting stream resulting in a very neat and accurate cut.

The term **cut** should be substituted for that of burn, for while burn is predominantly used wherever the process is applied its aim is to cut as if by mechanical means, instead of burn as by the melting method.

Burners should be educated into *steel cutters*. Proper instruction of this class by an operator or instructor.

Comparing the electric arc and the oxy-acetylene process in welding, with few exceptions the same operations may be accomplished with either.

The electric arc has a higher temperature than the oxy-acetylene flame and the greater part of its heat is produced in an extremely localized area within the metal to be welded rather than external to it, as is the case in the oxy-acetylene flame.

Up to the present time the electric arc welding process has been used almost exclusively in the welding of steel.

The matter of fastening two pieces of steel together is one of the fundamental problems of mechanical engineering, since all machines are made up merely of so many pieces of metal fastened together. The rivet is almost as old as the hammer and anvil. The threaded bolt and nut, as compared with the rivet, are recent inventions. The welded fastening came down to us from antiquity. The welded fastening has always been looked upon as a stronger joint than the riveted or bolted fastening. The reason that it was never more widely used until recent years has been due to the fact that only one way of making a welded joint was known, and that this was not applicable, except to a limited range of joints. As a general proposition the riveted joint, or bolted joint, has a tensile strength which is considerably less than the tensile strength of the original piece, while the welded joint is as strong as the original section. For instance, two pieces of boiler plate may be riveted together with four rows of rivets and double straps, and the tensile strength of the joint will not exceed 85 per cent of the strength of the original strength of the plate, yet it is quite a simple matter to weld a joint in the same plate, either by the old forge welding process or by a latter autogenous welding process, and obtain a joint that is as high in tensile strength as the original plate. The welded joint, and particularly the butt welded joint made by an autogenous welding process offers greater strength, with a thickness for practical purposes equal to the thickness of the original plate. This is a feat in mechanical engineering which has been unheralded, but ranks with the introduction of the power hammer, the pneumatic tool, and other great strides in mechanical engineering progress. There was a time when worn surfaces of the steel parts in a machine made it necessary to scrap those parts. There was no method of avoiding this practice. The wearing of a fraction of a cubic inch of metal from one of the bearing surfaces of a steel part made it necessary to scrap the labor investment in that particular part entirely.

It was only with the introduction of the autogenous welding process that it became possible to stop this economic waste. Viewed from the perspective of the last fifty years, the achievements made possible by the autogenous welding processes in the last five years are probably the most remarkable of any in the mechanical field. The first of the new welding processes, which may properly be called auto-

genous process, since the welding takes place more or less automatically, was the *thermit* welding process. In this process the metals to be welded, together with the additional quantity of metal of approximately the same composition, are heated to a liquid state by a chemical reaction, so that cohesion takes place while they are in the molten state. This process found a wide application in the repair of broken steel parts and the saving which resulted from its use, without doubt aggregated millions of dollars.

There are two kinds of electric arc welding, known respectively as carbon electrode and metallic electrode welding. In the former an arc is drawn between a carbon electrode and the piece to be welded and the metal to be added fed into the arc in the form of a "melt bar." This process is not used extensively, due to the fact that welding may only be done in the horizontal plane in this manner and the work is in general inferior to that which is possible with the metallic electrode process.

The metal electrode uses, as the name implies, a metal electrode, the arc being drawn between the electrode and the piece being welded. The heat of the arc melts the metal of the piece and the metal of the electrode simultaneously. As the metal of the electrode melts it is drawn across the arc to the molten metal of the piece where a complete homegenous union is formed, which we call an autogenous weld.

The following claims of superiority are made for electric arc welding as compared with other methods for materials and conditions for which the method is suitable: *First*, the high temperature of the electric arc makes it possible to rapidly reduce the metal to be welded to a molten state; the heat being applied rapidly is not carried away from the point of the weld by the heat conductivity of the metal fast enough to lower the temperature appreciably. *Second*, the tools for performing the weld are comparatively easy to manipulate and the apparatus required is simpler and easier to handle than that used with gas welding outfits. *Third*, for all work, except very thin materials, it is the cheapest welding method available. *Fourth*, the voltage of the current is so low that the process is perfectly safe, and if the operator is provided with a proper hood or shield to protect him from the light and heat of the arc, he is not exposed to any danger. The heat and light from the carbon arc are much greater than from the metallic arc. *Fifth*, there is no danger from explosions.

The most important of all advantages, probably, is that welds can be made overhead and on vertical seams by the metallic arc. Overhead welding can hardly be done by other means, and vertical welding only with great difficulty by other methods. The simplicity of electric welding for overhead and vertical seams is, therefore, one of its strongest claims in many instances.

About ninety percent of all electric welding by the use of metallic electrodes.

Practically all hot flame welding is done by the oxy-acetylene process.

Each system is best on certain classes of work. What is meant by that, is, that one system is suited to certain classes of work better than another.

It is up to all persons interested in welding to convince the public that welding is past the experimental stage and that it can be relied upon if the tools are put into the hands of a properly instructed and experienced person.

The writer believes welding "as stated in this article" is one of the greatest wonders of the age.

CLAUDE OXYGEN PROCESS.

Reader: In answer to your request for information relative to the Claude process of manufacturing oxygen, would state that this process, we understand, is the property of the Air Reduction Sales Co., Inc., New York City. For further information concerning this process, please refer to this company.—Editor.

IT'S READY FOR YOU

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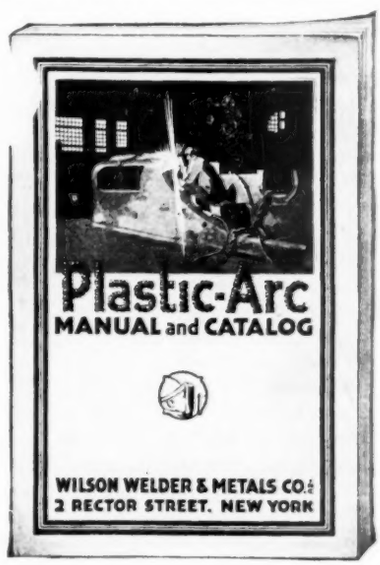

This new book of modern welding practise contains detailed descriptions of various welding methods, modern equipment, examples of welding small and massive parts of steel, iron, cast-iron, copper, brass, and aluminum, etc., with explanations that really explain the proper method, heat values, welding metals, etc., to be used for any particular job or line of work. Also a chapter devoted to the repair of the interned German ships, the biggest welding job in the history of the world.

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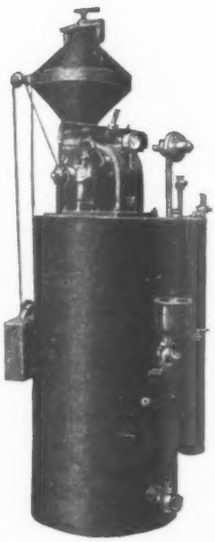

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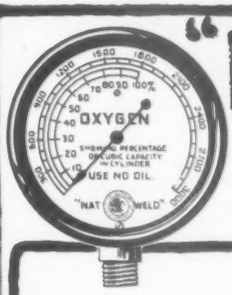

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OLD DOC THERMIT IS BUSY

It may be unprofessional for a physician to advertise, but that doesn't alter the fact that for surgery on roll necks, pinion teeth, etc., the Doc don't intend to hide his light under a bushel. The Metal & Thermit Corporation, who have charge of Doc's advertising, have just published one of his letters addressed to steel mills, and it reads as follows:

I was so much interested in reading the letter recently circulated among the steel mills, and entitled "How Thermit Healed My Broken Jaw," by Mr. Alligator Shear, that I have just had to write you about a similar operation which was recently performed on my neck.

While engaged in the strenuous daily work of rolling out steel plate, my neck became very badly strained, twisted and wasted away from wiggling around in its collar. The overstrain finally made me such a rough neck that I just plain had to quit the job, and refused to do any more work!

My boss naturally would not tolerate my idleness, so he sent for old Dr. Thermit. A mold box was then built around my neck and after heating it up until it got redder than a beet, the Doctor grafted some liquid Thermit steel on to the injured parts.

When I cooled off a few hours later my neck felt so strong that I could hardly wait before getting back to work!

Since my operation I have discarded faith in that old warning, "Set not thyself up with a stiff neck!" because my stiff neck gave me a new lease of life.

Yours truly,

R. M. PINION,
Care Universal Rolling Mill Co., Bridgeville, Pa.

The Welders and Burners Association of Greater Boston has been formed with about 300 members. Meetings are held on the first and thrid Mondays of each month at Deacon Hall, 1656 Washington Street, Boston, Mass. M. W. Shea, is president, Frank A. Donahoe, secretary-treasurer, and L. Lewis vice-president.

The Brotherhood of Gas and Electric Welders and Operators of America has been formed at Newport News, Va. Mr. C. B. Crawford, 124 34th Street, is secretary.

A circular has just been issued which briefly reviews autogenous welding, the opportunities for oxy-acetylene welders and cutters, and which also gives the terms of instruction in the D-B Institute. A copy of the circular will be sent upon request.

REPAIR OF A BROKEN DROP HAMMER COLUMN BY THE ELECTRIC ARC PROCESS.

By R. V. Gardner.

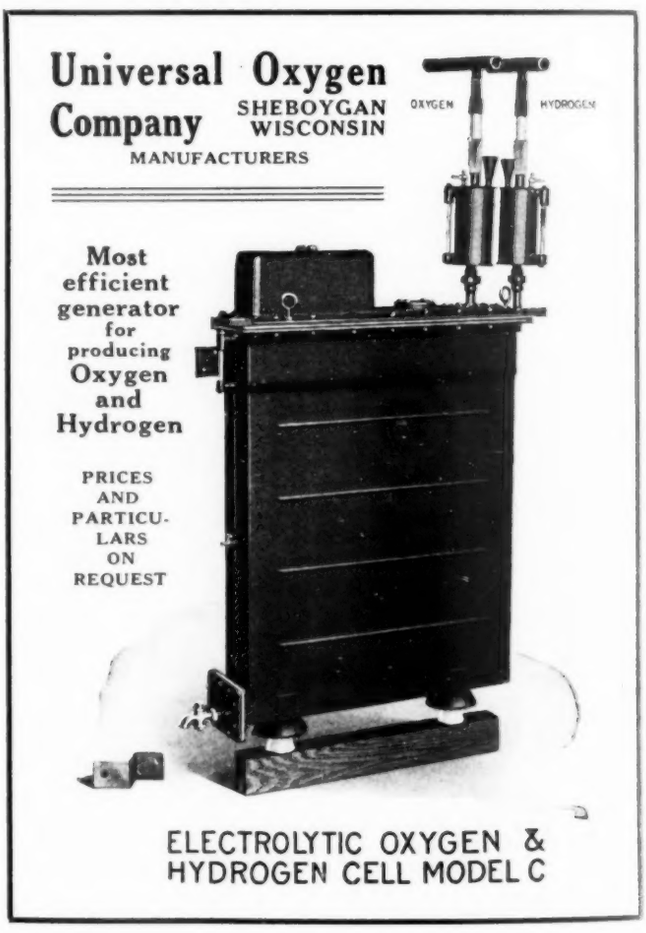
Large industrial plants, especially those connected with metal working, are realizing more and more every day that to be equipped to handle all classes of welding jobs in the most efficient and economical manner, it is desirable to have installed both Electric arc welding equipment as well as Oxy-Acetylene apparatus. Each process has its own particular field where it may be said to function more efficiently, and for any given case of manufacture, repair or reclamation, that process can be selected which is best adapted to the work in hand from the standpoints of quality, convenience, economy of time or cost of operation.

A recent case in point can be cited in the plant of a large manufacturer of forgings in the Chicago district. One of the columns of a 6,000-lb. steam drop hammer developed a fracture at the inside edge of the face of the column and near the top of the gib which guides the hammer in its reciprocating motion. The column was of cast steel and a large chunk of the metal had simply "jumped off" from the face of the column as expressed by the foreman. The hammer was not entirely out of commission, but was not being operated at its maximum capacity because of the possibility of further breakage.

Prior to the accident, it had been the custom of this company to send all large repair jobs of similar nature out to some of the larger Oxy-Acetylene welding shops in Chicago to be welded by the gas process. This procedure involved considerable time and expense in the items of dismantling, drayage, preheating, welding with gas, possible afterheating, cartage back to the plant, and reassembling. This method would in all probability have necessitated the shut-down of this particular machine of from a week to ten days, and the plant officials considered this inadvisable at that time.

Because of the time and expense involved in gas welding, the officials were more willing to listen to the representatives of a local commercial welding shop which was equipped with both Electric Arc and Gas Welding apparatus. After they had had an opportunity to study the operation and satisfactory results obtained with the Electric Process on cast steel, the job was let to the commercial company with the understanding that it was to be done by this method.

The original pieces which had broken from the column having found its way to the scrap pile, a new part was planed up to fit the break, provision being made for about an eighty degree groove all around the piece. This was first tacked in its proper position by spotting it at different points in the bottom of the groove with the arc. Vertical welding was then accomplished until the entire groove along one side and both ends of the 13x3-inch piece had been properly filled and reinforced. The top of the finished weld measured about four inches across and the depth of the fracture was 3½ inches.



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Automobile Owners, Garage and Service Stations, Blacksmiths and Machine Shops, as well as industries using the oxy-acetylene flame, will find this book of the utmost value, since the perplexing problems arising when metal is heated to a melting point are fully explained and the proper methods to overcome them shown.

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The welder used was of 200 ampere capacity and was made by the Lincoln Electric Co. of Cleveland, O. The metallic electrode process was used throughout, the wire being $\frac{5}{32}$-inch and $\frac{3}{16}$-inch diameter and of the proper analysis for cast steel welding. The energy consumed totalled 333-KWH for practically 36 hours of continuous welding.

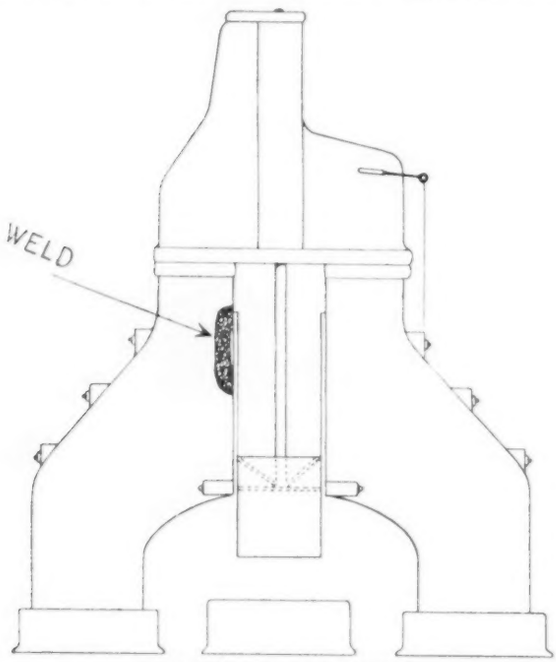
A feature in connection with this work was that the hammer was out of commission only about 2 hours. The work was accomplished over a week-end at a time when a legal holiday fell on Friday. This particular plant as well as many others was normally shut down from Thursday night until Monday morning. After about two hours chipping, the hammer was placed in service practically as good as new and ready for the heaviest work.

After one or two other repairs, similar but of less consequence, had been made by the commercial welding company, a 200 ampere Lincoln Welder was purchased for the plant, to be used in conjunction with their oxy-acetylene apparatus for the wide range of work quite generally encountered in a large forging plant.

A DIFFICULT JOB.

The enclosed sketch indicates construction of a peculiarly shaped flange which was required on some very important work. The section indicates a radius on the lower part of the flange. The threading required was for a 4-inch iron pipe plug.

Cast iron was unsatisfactory for several reasons pertaining to the work. Furthermore, very little time was allowed for making a pattern casting and machining of any other metal.



A Difficult Welding Job.

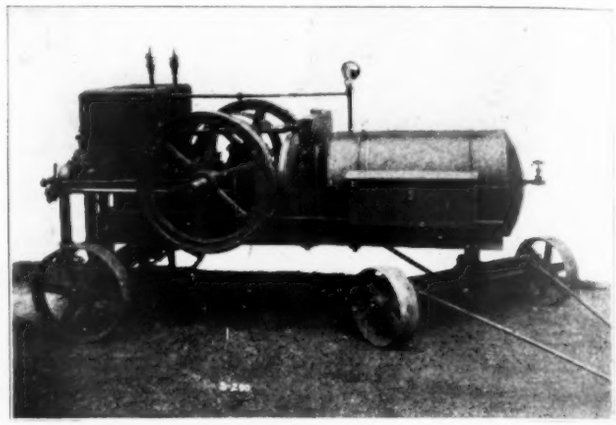
A 4-inch wrought iron pipe coupling was sawed in two and each section welded to a thin plate which had been previously cut out to shape with an oxy-acetylene torch, heated and bent to shape.

Two of these couplings required about three hours to complete as compared to a delay which might have meant several days had any other method been used.

Oxweld apparatus was used throughout the work, the acetylene being supplied from a low pressure generator.

Air Compressor for Job Shop.

The accompanying illustration of a typical portable air compressor for a job welding plant is furnished through the courtesy of Mr. R. E. Kinkead, of the Lincoln Electric Co., Cleveland. Air compressors are a very important item in the equipment of the up-to-date job welding plant and play an important part in the efficiency and economy of the plant's operation.



Portable Air Compressor for Job Welding Shop.

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The Davis-Bournonville Co., Jersey City, N. J., are announcing a new cabinet truck, the details of which are explained elsewhere in their advertisement in this issue.

Superior Brazing Compound.

The Standard Manufacturing Co., 318 South Canal Street, Chicago, announce increasing orders among welders for Superior Brazing Compound. This brazing compound contains over 98 per cent pure boron, a fact which makes the work of the brazer easy. Circulars will be sent upon request.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

of The Welding Engineer, published monthly at Chicago, Ill., for Oct. 1, 1919, state of Illinois, County of Cook, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared L. B. Mackenzie, who, having been duly sworn, according to law, deposes and says that he is the publisher of The Welding Engineer, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, L. B. Mackenzie, Chicago, Ill.; Editor, L. B. Mackenzie, Chicago, Ill.; Managing Editor, L. B. Mackenzie, Chicago, Ill.; Business Manager, L. B. Mackenzie, Chicago, Ill.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock.) L. B. Mackenzie, 7131 Crandon Ave., Chicago; M. J. Hungerford, 6107 Dorchester Ave., Chicago. The Welding Engineer Publishing Co.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

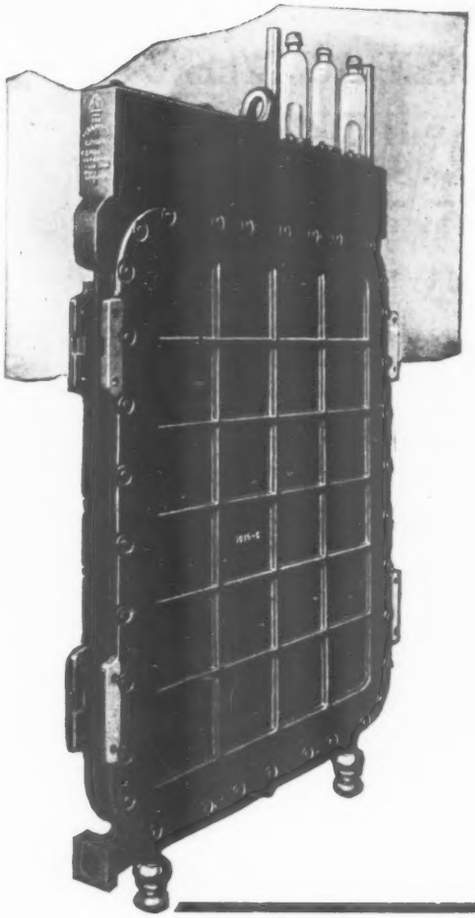
4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect, in the said stock, bonds or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the six months preceding the date shown above is..... (This information is required from daily publications only.)

L. B. MACKENZIE.

Sworn to and subscribed before me this first day of October, 1919.
(Seal.) R. GOULD.

(My commission expires Aug. 26, 1923.)



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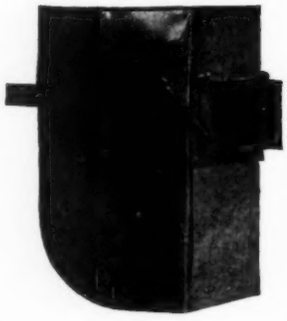

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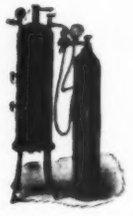

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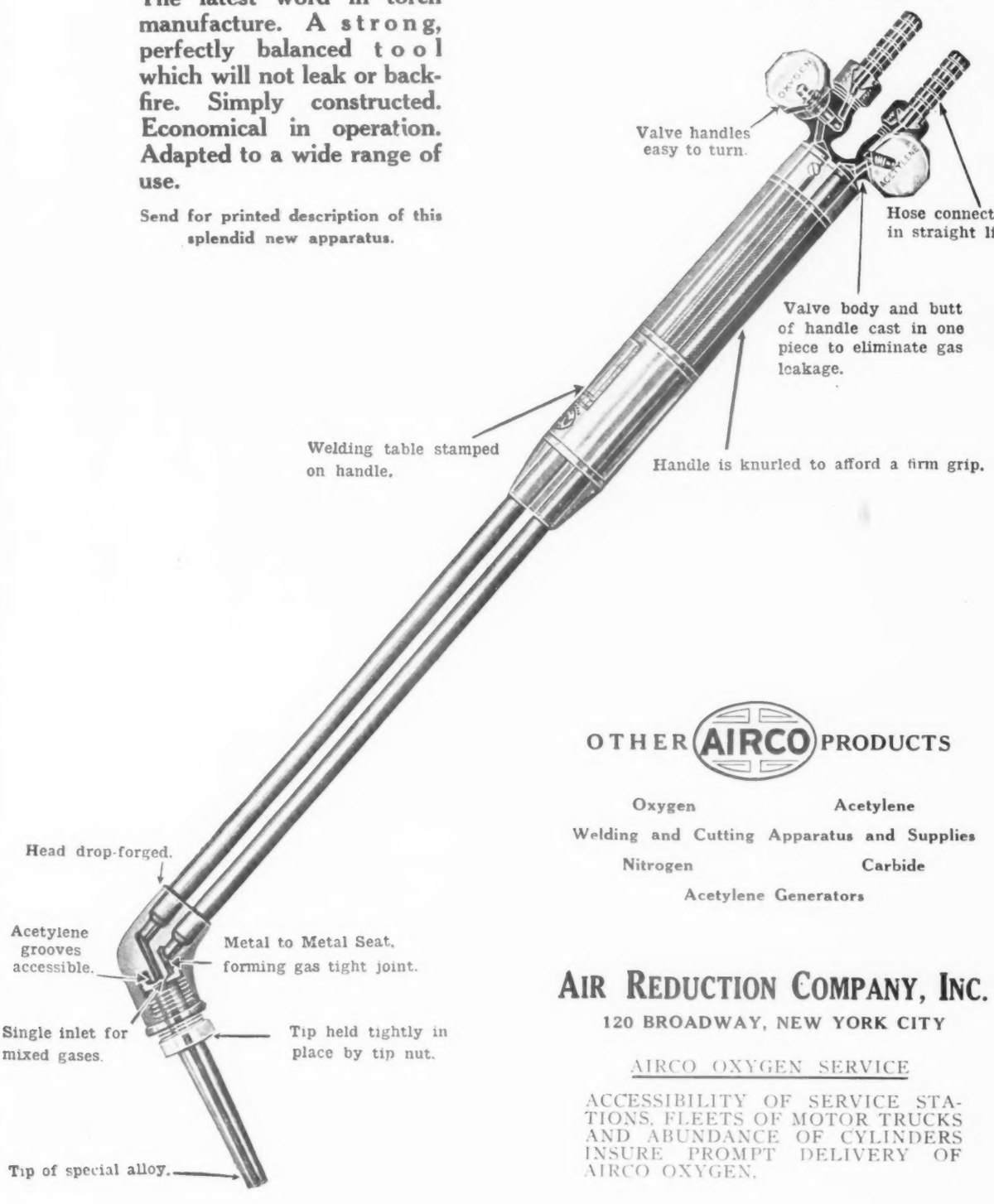
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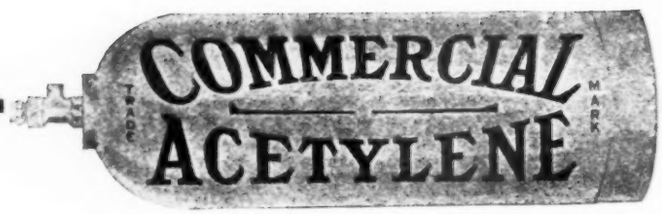

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